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S. HRG. 101-325

COMPARATIVE ASSESSMENT OF U.S. SPACE PROGRAM

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

COMPARATIVE ASSESSMENT OF U.S. SPACE PROGRAM

JULY 19, 1989

Printed for the use of the
Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PRINTING OFFICE

21-672 O WASHINGTON : 1989

S261-3

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

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COMPARATIVE ASSESSMENT OF U.S. SPACE PROGRAM

WEDNESDAY, JULY 19, 1989

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, DC.

The subcommittee met at 2:03 p.m., in room SR-253, Russell Senate Office Building, Hon. Albert Gore (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Marty Kress and Mike Nelson, professional staff members; and Louis Whitsett, minority staff counsel.

OPENING STATEMENT BY SENATOR ALBERT GORE

Senator GORE. The subcommittee will come to order, and I would like to welcome our witnesses and our guests and get us underway here.

This is an historic week, as everyone is quite well aware, because tomorrow does mark the twentieth anniversary of the landing of Neil Armstrong and Buzz Aldrin on the surface of the moon. On that day 20 years ago the eyes of the world focused on the technological prowess of the United States and the three brave men who risked their lives to realize what had been a national dream.

It was a day when we were especially proud to be Americans. It was a time when goals and commitments could be translated into action. It was an event that also influenced the lives of our children, even their career choices. Those of us old enough to remember will never forget that day, and never forget Neil Armstrong's prophetic words, "That's one small step for a man, one giant leap for mankind."

During the past week there has been TV special after TV special and article after article about the Apollo mission. For me this anniversary has been a time for celebration and reflection, celebration because Apollo truly was one of the greatest accomplishments in the history of humankind, reflection because there is one consistent theme in all of these stories that concerns me somewhat. There seems to be a sense that that is how we did things back then, as if to imply that we could not do it again today if we set out to achieve the same goal or one comparable to it.

Since 1969 we have been debating the overriding goals of the space program, and rightly so. Goals are important and particular-

ly important if we dedicate our energies and resources to achieving those goals.

Most recently the debate over the goals of the space program has been rekindled in the White House where a series of options outlined in both the Paine Commission report and the Ride report are now being assessed. I welcome such high level interest in the space program. But I am concerned that in our effort to celebrate the past and the Apollo mission with the bold initiative for the future, we may be overlooking the pressing budgetary and programmatic problems of the present.

I want a viable budget, and a White House commitment for Mission to Planet Earth, and the space station. However, before we start deciding on another space spectacular, I want a well-defined space policy with a clearly defined Federal role that ensures U.S. leadership and market share before we venture to Mars.

I strongly support a mission to Mars. I think it is the logical step. But as a first small step toward getting there, we have to save NASA and provide funding for our present efforts in space. I would like to resolve, too, the many pressing personnel problems within NASA and other parts of the Federal Government and formulate a clear policy to attract and retain the best and brightest in public service.

From my vantage point, the race for space in the 1990s looks dramatically different from the race for space in the Apollo era. No longer are the United States and the Soviet Union the only participants. Now the field is crowded. No longer is the goal military superiority or technological prowess. Today one of the goals is also market share, new products, new industries. Where does the United States stand, therefore, vis-a-vis the other nations of the world in this current race for space?

Today this subcommittee will attempt to put these questions and issues in perspective by trying to formulate a net assessment, a comparison of the U.S. civil space program in relation to the programs of other spacefaring nations. We will try to elucidate where we are today, where the competition is, and where we are headed.

To undertake this review, the subcommittee is pleased to have Mr. Kenneth Pederson, Associate Director of NASA for External Affairs; Mr. Michael Michaud, Director of the Office of Advanced Technology in the State Department; and Ms. Marcia Smith, a Specialist in Aerospace Policy from the Congressional Research Service.

Having received this net assessment, we will then be better prepared to assess NASA and White House proposals, some of them forthcoming tomorrow, to chart a course for the future. It is because we are concerned about the future that we are also pleased today to have seven students, ranging from the elementary to the graduate school level, who will testify about how the space program has influenced their schoolwork, and what they think the future goals and objectives of the civil space program should be.

I would like to thank each of these students for their willingness to appear today. They are our country's future, and oftentimes a source of wisdom in the present. I should note that each of these students is or has been involved with the Young Astronauts Coun-

cil or a NASA educational program, and has been selected by their respective organization to testify today.

Well, we have an ambitious schedule this afternoon, but I hope the hearing is well-designed to serve as a forum during Apollo Week, and I would hope that at the end of this hearing, we will thoroughly understand where we are today in the race for space and have a consensus on which of today's dreams should be tomorrow's realities.

Now, before going to our first panel, let me mention one housekeeping item. We are engaged in a debate on the floor of the United States Senate right now on an amendment that I have sponsored to the State Department authorization bill, and I am hoping that debate turns out well without my presence. But I am a little more concerned that I be there personally for the actual vote when it takes place, and so when the bells ring for a vote, we will search for a logical break point in this first panel. And then after the vote has been completed, I will come back, and we will crank up the hearing again, and hopefully move on through to an uninterrupted conclusion after that if there are no further votes.

Let me announce that Senator Hollings, who is, of course, the Chairman of our full committee and has always been extremely active on space policy, has a statement for the record. He is involved at this very moment in discussions about some appropriations matters that are vitally important to the issues we are discussing here.

Also, Senator Kerry, a member of our committee, wished to be here, but the Foreign Relations Committee has a bill on the floor.

[The statement follows:]

OPENING STATEMENT BY THE CHAIRMAN

Twenty years ago, this Nation fulfilled a dream—it sent three astronauts to the moon and returned them safely to Earth; it met a challenge—the threat of Soviet military superiority; and it fulfilled a commitment—the commitment of John Kennedy to complete this mission within a decade.

But despite the Apollo success of 1969, the U.S. failed to capitalize on this accomplishment because too few persons realized that the race for space didn't end with the moon—the moon was just the beginning.

Since 1969, there have been a lot of changes in the scope and direction of the Nation's space program, and there have been a lot of changes in the status of our space program. The United States was the uncontested leader in space in 1969, in 1989 the U.S. finds that its leadership has evaporated in many key areas including space transportation and manned space activities and that we are being seriously challenged in other areas such as space applications (communications satellites, remote sensing and microgravity research) and space science.

In 1969, three nations had an independent launch capability. In 1989, there are seven nations with an independent launch capability, and that number is likely to grow in the near future. In 1969, two nations had put astronauts/cosmonauts in space. In 1989, twenty nations have sent astronauts/cosmonauts to space on U.S. or Soviet spacecraft.

In the area of space applications, the United States is not alone in its pursuit of markets. Even the Soviets are mirroring the U.S. with the creation of a separate commercial space agency, Glavcosmos, dedicated to marketing their space services and advertising. The United States leadership in commercial launch services has been abducted to Arianespace, and its leadership in remote sensing is being challenged by SPOT Image. As for communications satellites, the nations of the world are working to overtake our lead and being able to develop satellites with no U.S. components. This has created a conflict between the Nation's satellite and expendable launch industry as we compete in a most competitive international marketplace.

Today, we have gathered three experts to give the Committee a net assessment of where the United States space program stands vis-a-vis the programs of the other spacefaring nations of the world. In particular, we have asked these witnesses to focus on space transportation, manned space activities, space science, space applications and space research and technology. We also have asked them to discuss the benefits of cooperation, as well as the challenges of competition.

Based on their presentations, I hope we are all more aware of the scope and dimensions of space in the 1980s and the challenges that confront us during the decade of the 1990s. As the business Higher Education Form Report, "Space: America's New Competitive Frontier," noted:

"It is ironic that the nation that has made the greatest contribution of space technology to the world should now be in danger of losing that lead . . . During this decade, advanced foreign capabilities have or will become comparable to those of the United States in virtually every area of civilian space technology except manned space."

It is important that the Members of this Committee and the Congress understand the competitive position of the Nation's space program so that we don't wake up one morning and find that our leadership in space has gone the way of our leadership in consumer electronics, steel and autos. We need to decide what our priorities are, and we need to meet them.

I also am pleased to welcome the seven distinguished panelists who will comprise Panel II today. If there is one thing we all agree upon on Capitol Hill, it is the importance of our youth to the future of this Nation. Therefore, as we debate the goals and objectives of the space program, it is most appropriate that we call upon the scientists, engineers and voters of tomorrow for their views of where this Nation should be headed.

As Lyndon Johnson said in 1958 during consideration of the original Space Act:

"I believe that it is entirely fair to say that seldom, if ever, has a Congress and an Admnmistration faced a more challenging task. We are dealing with a dimension—not a force. We are dealing with the unknown—not the known. While the present is urgent, the real imperative is the future. What we do now may very well decide, in a large sense, what our Nation is to be 20 years and 50 years and 100 years from now——"

There are important times, and this is an important hearing. And I look forward to today's testimony.

Senator GORE. So our first panel has already been introduced. Again, let me thank you all for being here. Without objection, your prepared statements will be included in the record in full. We invite you to proceed with a summary of your presentation, and we will begin with Mr. Kenneth Pedersen, the Associate Administrator for the Office of External Relations at NASA.

Congratulations on NASA's celebration this week, and please proceed, Mr. Pedersen.

STATEMENT OF KENNETH PEDERSEN, ASSOCIATE ADMINISTRATOR, OFFICE OF EXTERNAL RELATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. PEDERSEN. Thank you, Mr. Chairman.

With your permission, I will summarize my statement for the record.

The committee has asked this panel to address a large number of issues—indeed, a tall order. I have attempted to organize my thoughts under five broad headings, and in the process attempted to do a bit of a comparison not only between nations, but something about where we stood 20 years ago in terms of space internationally and the situation or context in which international space activity is taking place today.

Those five topics deal with: (1) The priority being attached by the major space players to assured access to space and the expanding development of indigenous launch capability around the world; (2)

the growing participation in manned space activities as a key element of national and regional space capability; (3) the increasing focus of nations on space commercialization; (4) the changing pattern and broad diversity of international coalitions and partnerships we see emerging almost daily; (5) and the growth of international cooperation in spite of the increasingly competitive international space environment. I will try to address each of these topics briefly.

With respect to assured access to space and space transportation, as we look back through history we find that the two spacefarers of 1969, the United States and the U.S.S.R., now both have in place strong policies of seeking robust assured launch capability through maintaining a diversity of national systems. On our part, we went through an ill-advised and short-lived policy of attempting to move toward total reliance on a single system. Fortunately, that policy, even before the Challenger tragedy but certainly on an expedited basis afterwards, has been replaced by the current U.S. mixed fleet policy, which utilizes the shuttle and a stable of expendable launch vehicles to assure this country with access to space.

At the same time, we are actively looking at future concepts such as Shuttle-C or the advanced launch system to assure that we remain competitive and that we remain independent. The Soviets also use a broad range of well-proven vehicles, some drawing upon technology dating from the 1960s. The workhorse of their fleet for many years has been the Proton, but they have a number of vehicles and a very impressive space launch infrastructure. They use three major launch sites, with a number of pads at each site. This enables them to maintain a very high launch rate, on the order of 100 launches a year.

We have seen that the Soviets have the capability to have an on-pad accident or problem and yet be back and launching again within a matter of days. When you launch as often as the Soviets do, with proven, evolutionary designs, you are in a position to treat launch failures as statistical incidents, rather than having to be concerned with whether they are major design failures.

Senator GORE. Let me interrupt with a brief question here. We see television coverage of most every American space launch. We rarely see coverage of Soviet space launches. If there is something unusual we will see it. But just because we do not see it, does not mean it is not going on.

Could you tell us how frequently do the Soviets launch into space? How many times a year?

Mr. PEDERSEN. The Soviets have averaged about 100 launches a year. Now, that is both civil and military launches.

Senator GORE. So they have a launch into space roughly every three days?

Mr. PEDERSEN. Give or take, yes.

Senator GORE. And what is the comparable figure in the United States?

Mr. PEDERSEN. We have been averaging about 10 to 12.

Senator GORE. So an order of magnitude difference?

Mr. PEDERSEN. If I might just insert something, though. Sometimes those figures are used out of context to suggest that they are or an order of magnitude superior to us. In many cases they launch

more frequently because the technology of their satellites is inferior. Their satellites have much shorter lifetimes than ours. So you cannot use just launch rate, Mr. Chairman, as a measure.

Senator GORE. Well, I do not intend to, and I take your point well. But still, as your previous paragraph suggested, there are significant advantages when a nation has a routine presence in space with the magnitude of launches that the Soviet Union now has.

Mr. PEDERSEN. There certainly are operational advantages. There is no question about that.

The Soviets are also working on a number of new systems and are actively seeking to make their new Energiya heavylift vehicle and their Buran shuttle, which has now flown in an un-manned mode one time, into operational systems. And they have announced—and perhaps Marcia Smith will want to say more about this—they have announced plans for increasing the Energiya lift capability beyond its current capacity of some 200,000 to 220,000 pounds to low earth orbit.

You have already referred to, perhaps the most interesting development over the course of the last 20 years, Mr. Chairman, and that is the growing number of countries that have entered the space environment and have been seeking their own independent access to space. Perhaps the most familiar one is the European Space Agency with its family of Ariane launch vehicles. They now have the workhorse of their fleet for the future in place, the Ariane IV, which has, by using a variety of strap-ons, a number of capabilities. It has at least four different configurations and can lift between 4,000 and 9,000 pounds into geostationary transfer orbit.

The Ariane was designed by Europe and optimized for launching satellites into geostationary orbit. It was designed to be an effective vehicle for competing for commercial launches. And indeed, the success of the Ariane enterprise is well-known.

Arianespace, the marketing arm of the Ariane launch family, commands about a 50 percent share of the global commercial launch market, and clearly has aggressive plans to continue at this level or higher in the future. The Europeans also are developing the Ariane V, their next generation of vehicle, which is scheduled to become operational in 1995 and will be capable of putting 6.8 tons into geostationary orbit and up to 21 tons into low earth orbit. It will be the vehicle that will launch their space plane, the Hermes, which is now also under development, principally to service their module on the Space Station Freedom, but also to service their own independent, man-tended free flyer. The Hermes, as currently configured, will carry a crew of up to three and a payload of up to 3,000 pounds.

Japan, too, is in the process of becoming a major player in the area of space transportation. Beginning in the early 1970s the Japanese developed a number of launch vehicles, but they were largely derivations of U.S. licensed technology. And as a result of transferring this technology to the Japanese, we retained certain approval rights, which gave us a measure of control at least over the development of the Japanese program.

For example, the Japanese were not in a position to launch satellites for third countries without U.S. approval. However, the Japanese are now in the process of developing a new launch vehicle

called the H-II, which is scheduled to be operational in 1993. The previous U.S.-Japanese agreement will not apply to the H-II, which will, for the first time, provide the Japanese with fully autonomous or fully independent access to space. The Japanese are also developing a space plane, the HOPE, which is now planned to be an unmanned vehicle, but provides them with the base of technology for future manned vehicles, which they do have in their national space plan.

A few words about the Chinese. The Chinese have had a launch capability since the early 1970s, but it has only been in recent years that they have become a serious global player with the Long March vehicles. These vehicles have good reliability and proven technology, and the Chinese have been aggressively marketing their commercial launch capability. The Long March II-E is due to be in service by 1990, and will be able to put 8.8 tons into low earth orbit. It is claimed to be compatible with international upper stages, which will make the Chinese an even a more formidable competitor.

As you are probably aware, Mr. Chairman, recently an agreement was reached between the U.S. and China to allow three U.S.-built satellites to be launched for foreign customers aboard the Long March. The export of these satellites has been deferred under the recently imposed trade restrictions.

Launching capability has not been confined just to the experienced and large industrial countries. Other countries as well are actively seeking to enter the game. Israel launched its first test satellite last year. India has been launching satellites since 1980 and is pressing forward with a larger launch vehicle. Brazil and Pakistan are also working on their own launch vehicles.

If we look at the area of manned space flight, we once again can see a growing convergence of interest in being a player not only in terms of human access to space, but having a role in manned operation in the space environment. Europe, Canada and Japan have all decided to play major roles in the development of Space Station Freedom, and around that commitment they are building an embryonic core of manned programs using access to both U.S. and Soviet flight opportunities.

The U.S.S.R. has flown cosmonauts from virtually all of the Warsaw Pact countries and is flying a growing number of individuals from western nations as well, including flights to and stays aboard their Mir space station. Some of these flights have been arranged with government agencies, while others, for example flights involving Japan and the U.K., have been sold to private consortia on a commercial basis.

The Soviet Union has a sizable lead over the U.S. in the area of long duration manned space flight. Although the Soviets have temporarily vacated the Mir station, there is no reason to assume, in my judgment that they have abandoned their long-term manned space flight objectives. On the contrary, developments in Europe and Japan reaffirm the importance—long understood here and in the Soviet Union—of the human element in constructing a fully formed space program capable of generating broad public and political support. Indeed, this country's Space Station Freedom is a key

capability in our determination to close the gap in this one area where the Soviets hold a clear pre-eminence.

Perhaps the most striking space development of recent years has been the growing emphasis placed on turning space activities into profit-making enterprises. Ironically, some of the most aggressive marketers of commercial space services have been the Soviets and the Chinese, largely motivated by the opportunity to acquire hard western currencies in return, but they are also well aware of the international prestige that being a player in this market place activity provides them.

One thing seems clear, and that is that governments in both the East and West are struggling to accommodate themselves to space commercialization. I think for the Chinese and Soviets the most difficult obstacles relate to adjusting their hidebound state industries and non-market economies to the often harsh demands of the capitalist marketplace while trying to overcome western concerns about technology transfer.

In the West the issue is more often one of determining the appropriate role of government in fostering commercial space enterprises. Speaking for myself at least, it seems clear that the costs and risks of operating in space are formidable and probably are not commercially viable in many cases without some form of government support or involvement.

In fact, if we look at a series of European examples, we find that in most of their so-called commercial operations they have established, governments continue to play a large role. For example, Arianespace, perhaps the best-known commercial space firm, is one-third owned by the French space agency, CNES. And Arianespace, like U.S. commercial launch vehicles, benefits from government funding of vehicle development.

A similar pattern of government-commercial partnership is visible in the French SPOT remote-sensing satellite program. They have set up a quasi-public entity spotimage, to market SPOT data on a commercial basis, but at the same time the French government continues to be responsible for developing and funding the SPOT satellites. So to be judged a commercial success, Spotimage needs basically only to achieve a commercial return on its data distribution activities and not to cover the much larger cost of developing and launching remote-sensing satellites.

European governments have also been very active in creating special organizations to promote commercial use of space. The French, for example, have created an organization called Novespace to promote the transfer of space technology into non-space areas in France. They have created another organization, also a subsidiary of the French space agency, called Prospace, which promotes French space-related industries abroad. Even the Soviets have created an organization called Glovcosmos, which has taken the lead in becoming in effect a Soviet commercial space corporation, and it markets a broad range of Soviet space products: launches, flight of instruments on Mir, cosmonaut flight opportunities, and remote-sensing imagery.

A quick word about the changing nature of cooperative relationships. We see increasingly, as you indicated, Mr. Chairman, that there are simply a lot more players with broad and impressive ca-

pabilities. As a result, NASA finds itself not always having to play the lead role in joint projects; in fact, in many cases we can derive substantial benefits by joining in a junior partnership role and in sharing the full fruits of the cooperation.

For example, in the NASA–ESA Solar Terrestrial Science Program, STSP, ESA is bearing the major share of the cost and is playing the lead project management role. We are providing a launch for one of the satellites and contributing some of the science instruments, and will share fully in the data that are recovered. Moreover, STSP is fully complementary to our own Solar Terrestrial Program, and we judge it to be an extremely good deal for NASA.

Similarly, we have an arrangement with the French on the Topex/Poseidon project, an ocean sensing satellite, in which we will develop the spacecraft, and the French will provide a free Ariane launch, and we will share once again the data.

It is clear, to my mind anyway, that the ability of the U.S. to control the shape and course of international cooperation is more limited today than it was in the past. We find that our partners increasingly possess competitive technologies and a growing number of options. One only has to look at the arrangements for Space Station Freedom where, in return for over $6 billion of investment in the space station, we have agreed to share certain management operation decisions with our partners in the station.

Contrast this, for example, with earlier infrastructure cooperative programs like the Remote Manipulator System or Spacelab, where the foreign partner developed the facility with their own money and technology and then turned it over to NASA to own and operate.

We find that today, with increasing equality around the world, we have to be prepared to share with our partners in new and different ways. That may differ from the past, but the benefits we can derive from them by virtue of their increased capability and maturity have led us to believe that these are good, and indeed productive and cost-effective arrangements for the U.S.

Despite the fact that I talked earlier about growing competition and commercial concerns, I think we can see a great interest in continuing to work cooperatively across a broad range of space projects. Sometimes a concern is expressed about technology transfer, and it is a valid concern. To that I can only say that NASA has successfully faced the challenge of protecting U.S. technology throughout its long history of international collaborations. In fact, as space-related experience and capabilities expand overseas, we find that NASA's partners are every bit as concerned about protecting their technology and their commercially promising ideas as we are. In some cases this has actually eased rather than complicated our negotiations.

Quite frankly, there is a greater recognition of the need for cooperation today than perhaps at any time in the past. The scale of projects we have in mind is greater, the problems are frequently global, and the costs, if you will pardon the pun, are often astronomical.

The current international concern for the changing global environment provides a striking example of an area that must be ad-

dressed internationally. And you are familiar with our International Space Year activities and our effort to involve our partners and erstwhile adversaries in this program.

Finally, I could not close without noting that U.S. national space policy does establish the expansion of human presence and activity beyond earth orbit as a major, new, long-term goal for the United States. Clearly, outposts on the moon or expeditions to Mars are inherently ambitious and expensive programs.

On the eve of celebrating the twentieth anniversary of the Apollo moon landing, policymakers are beginning to confront this new American goal. While it is too soon to anticipate how this epic journey will unfold, it is certainly possible that the space age, which began and spent its early years in a bipolar world of intense Cold War competition, may be witnessing an explosive era of cooperative exploration involving the talents and citizens not only of the experienced spacefaring nations, but many of the new players as well.

Thank you, Mr. Chairman.

[The statement follows:]

Statement
of

Kenneth S. Pedersen
Associate Administrator for External Relations

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Science, Technology, and Space
Committee on Commerce, Science, and Transportation
United States Senate

Mr. Chairman and Distinguished Members of the Subcommittee:

Thank you for your invitation to testify on NASA's views on the relative status of the U.S. space program vis-a-vis the space programs of other space-faring nations, including the critical changes which have occurred in the past twenty years.

The Committee has asked this panel to discuss the relative status of the various international players in the space arena; to examine the activities of those players in areas as diverse as current and future space science, space research and technology, space transportation, manned space operations, and space applications; and to compare those findings with the relative situation as it was at the time of the Apollo program. Needless to say, this is a tall order. I will seek to respond to your request by discussing five major themes which illustrate the current and changing state of the international space community over the past twenty years. These themes may help to put international space developments in some context and provide the Committee with some food for thought.

The five topics are: 1) the priority attached by major space players to assured access to space and the expanding development of indigenous space launch capability; 2) growing participation in manned space activities as a key element of space capability; 3) an increasing focus on space commercialization; 4) the changing pattern and broad diversity of international coalitions and partnerships; and 5) the growth of international cooperation in spite of the increasingly competitive international space environment.

Assured Access to Space

Assured access to space is vital to the success of any space-faring nation, whether its interests lie in communications satellites, microgravity research, manned space operations, remote sensing, or space science. Obviously, two options are available - to depend on the space launch capabilities of other space-faring nations or to develop an indigenous capability.

The two space-farers of 1969, the United States and the USSR, both seek robust assured launch capability through maintaining a diversity of national systems. After an ill-advised and short-lived policy of total reliance on the STS system, the current U.S. mixed fleet policy which utilizes the Shuttle and a stable of ELVs, is aimed at providing assured U.S. access to space. Other launch system concepts, such as Shuttle-C and the Advanced Launch System, are under careful study to ensure that the U.S. remains competitive and independent.

The Soviets also use a broad range of well-proven vehicles, some dating from the 1960s. The Proton is the most popular vehicle, capable of launching 21 tons in low earth orbit and two tons in geostationary orbit, and can achieve various planetary trajectories (Figure 1). The Soviets have three major launch sites, and with their various vehicles and multiple launch pads, can reach a high launch rate - approximately 100 launches in 1988 - and maintain a virtual launch-on-demand capability. In addition to the relatively new Zenit ELV, the Soviets are currently working to make the Energiya heavy lift vehicle and the Buran shuttle (Figure 2) into operational systems, and have announced plans for increasing Energiya lift capability beyond the current 200,000 pounds to low earth orbit.

Not surprisingly, over the course of the last twenty years, a growing number of countries have determined that an independent launch capability is essential to securing their futures in space. After depending for years on the U.S. for launch services, Europe, through the European Space Agency (ESA), has developed the versatile and commercially successful Ariane family of vehicles (Figure 3). The Ariane IV is the chief vehicle for the foreseeable future. Arianespace, the European "commercial" launch firm now operating the Ariane vehicles, plans to conduct ten Ariane IV launches annually, servicing a world-wide market. The Ariane IV has four different possible configurations, and can lift from 4000 to 9000 pounds into geostationary transfer orbit. Ariane V (Figure 4), a next-generation vehicle with man-rated status, is scheduled to become operational in 1995. It will be capable of placing 6.8 tons into geostationary transfer orbit, or 21 tons into low earth orbit. The success of the Ariane enterprise is well-known. Arianespace commands at least a 50 per cent share of the global commercial launch market, and has aggressive plans to continue at this level or higher in the future.

ESA is also developing the Hermes spaceplane which will provide Europe with manned access to space. Hermes (See Figure 4) will be launched on an Ariane V, and its first flight is scheduled for 1998. The primary mission for Hermes is to support the European Columbus program's Man Tended Free Flyer and the European laboratory module on Space Station Freedom. Other missions are being explored. The vehicle will carry a crew of up to three and a payload of up to 3000 lbs.

Beginning in the early 1970s, Japan developed a series of launchers utilizing licensed U.S. Delta ELV technology under license. As part of the licensing arrangement, the U.S. Government retained certain approval rights which, among other things, limited the ability of Japan to launch satellites for third parties. The Japanese are now developing a new launch vehicle, the H-II (Figure 5), capable of placing over two tons in geostationary orbit or ten tons into low earth orbit, which will rely exclusively on Japanese technology and is scheduled to be operational in 1993. The previous U.S. Japanese agreement will not apply to the H-II, which will for the first time provide Japan with fully autonomous access to space.

Japan is also developing a spaceplane, the HOPE (the H-II Orbiting Plane, Figure 6), scheduled for flight in the late 1990s. Although this will be an unmanned vehicle whose mission will be to carry supplies and equipment to and from the Japanese Experiment Module on Space Station Freedom, a primary objective of the HOPE program is to develop technology for future manned vehicles.

Although the PRC has had space launch capability since the early 1970s's, only in recent years has China become a serious global player with its Long March vehicles (Figure 7). The Chinese vehicles have good reliability and use proven technology. The Chinese have been aggressively marketing launch services on an international basis since 1985. The Long March-3A is designed to launch 2.5 ton payloads into geostationary transfer orbits, which allows it to compete for most business on the international market. Due to be ready for service by 1990, the Long March-2E will be able to put 8.8 tons into low earth orbits and is claimed to be compatible with international upper stages. Recently, an agreement was reached between the U.S. and China to allow three U.S.-built satellites to be launched for foreign customers aboard the Long March. Export of the three satellites to China for launch has been deferred under the recently-imposed trade restrictions, although some interface data for one of them has been approved for export in the interim.

Ambitions for an independent launch capability reach beyond the economic and political superpowers. The Indians have been launching small satellites since 1980, and are pressing forward

with a larger launch vehicle despite some early failures. Israel launched its first test satellite last year, and Brazil and Pakistan are also working on their own launch vehicles.

Further in the future, several nations are planning manned hypersonic vehicles providing horizontal take-off access to space. The U.S. NASP single-stage-to-orbit program is familiar to everyone here. The Germans are also working on the Saenger (Figure 8), a two-stage reusable hypersonic vehicle. For several years, the U.K. supported technology development of the HOTOL concept, although government funding has now been suspended. The Japanese are also pursuing hypersonic research and technology programs, which might build on experience gained in the HOPE program. The Soviets are pursuing generic research programs, and have announced a program to develop a vehicle capable of reaching a velocity of up to Mach 5.

Manned Space Capabilities

Twenty years ago, the U.S. and the Soviet Union were the only nations sending humans into space. The European commitment in 1973 to develop Spacelab was a key milestone in the maturation of other nations' space programs, a process in which a number of nations have concluded that attainment of manned space flight should be an integral part of their programs. Canada, Europe and Japan, through their decisions to play a major role in the development of Space Station Freedom, are at the forefront, and other countries are also building embryonic manned programs around access to U.S. and Soviet flight opportunities.

The first Western European flew on Spacelab-1 in 1983, and seven non-U.S. astronauts have flown on the Shuttle since then. Europe is making an extensive effort to develop a well-qualified cadre of European astronauts to serve aboard Space Station Freedom and to carry out Spacelab missions in the 1990's and beyond. Canada and Japan are also preparing astronauts to fly on the Space Station. German, Japanese and Italian payload specialists will fly on a German Spacelab mission, a Japanese Spacelab mission, and the first flight of a cooperative Tether Satellite, all in the 1991-92 time period.

The USSR, meanwhile, flew cosmonauts from each Warsaw Pact country to their Salyut space stations during the late 1970's. beginning with France in 1982, a growing number of Western nations have accepted Soviet invitations to fly cosmonauts aboard Soviet space stations, including Mir (Figure 9). Some of these flights have been arranged with government agencies, while other pending flights - involving Japan and the U.K. - have been sold to private consortia on a commercial basis.

The Soviet Union has a sizable lead over the U.S. in the area of long-duration manned spaceflight. Although the U.S.S.R. has temporarily vacated the Mir station, there is no reason to assume that they have abandoned their long-term manned spaceflight objectives. On the contrary, developments in Europe and Japan reaffirm the importance, long understood in America and the U.S.S.R., of the human element in constructing a fully-formed space program, capable of generating broad public and political support. Space Station Freedom will provide the capability to close the gap in this one area - long-duration flight - where the Soviets hold a clear pre-eminence. The Soviet lead does not extend to manned transportation systems. While the Soviets have developed a reusable space shuttle, similar in many respects to the U.S. vehicle, the Buran has had only one unmanned test flight and may not fly with a crew aboard for some time to come.

Commercial Space

Perhaps the most striking space development of recent years has been the emphasis placed on trying to turn space activities into profit-making marketplace enterprises. Under increasing budgetary pressures, space agencies around the world are seeking to achieve some near-term return on their investments in space while creating viable long-term commercial space industries. Ironically, some of the most aggressive marketers of commercial space services have been the Soviets and the Chinese, largely motivated by the opportunity to acquire hard Western currencies in return.

Experience both in the U.S. and abroad has demonstrated that there is no single, monolithic commercial space industry, and that the needs of the various sectors into which the industry is divided differ significantly. In the West, for example, the communication satellite industry is well-established and has a well-defined commercial market. The commercial space launch industry is less established, but has a solid technology base and a cadre of government and private sector customers. The remote sensing sector has portions that appear commercially viable - largely in the area of data processing and marketing - but cannot yet cover the large costs associated with satellite development and launch out of revenues from data sales. Microgravity materials processing, an area of great promise, is for the most part still in the basic research phase.

One thing seems clear, governments in both East and West are struggling to accommodate themselves to space commercialization. For the Soviets and Chinese, the obstacles relate principally to adjusting hidebound state industries and non-market economies to the often harsh demands of the capitalist marketplace while overcoming Western concerns about technology transfer. In the West, the issue is more often than not one of determining the

appropriate role of government in fostering commercial space enterprises. The costs and risks of operating in space are formidable and, as a result, few current commercial undertakings are viable without some form of government support or involvement. Thus, Arianespace, perhaps the best-known "commercial" space firm, is one third owned by the French space agency CNES, and, like U.S. commercial launch vehicle firms, benefits from government funding of vehicle development.

The European Retrieval Carrier (EURECA), developed by ESA, illustrates another form of governmental/commercial partnership. (The EURECA is a Shuttle-launched spacecraft which is put into orbit for several months and then retrieved by the Shuttle.) Following the first flight of EURECA on the Shuttle in 1991, ESA is encouraging an industrial consortium, which includes G.E. as a U.S. participant, to market and operate a commercial variant of EURECA called AMICA (Figure 10). ESA and the European governments are seen as the primary customers for both spacecraft.

A similar pattern of government/commercial partnership is visible in the French SPOT remote sensing satellite program. SPOT-1 is equipped with two pointable sensors capable of 20-meter multi-spectral and 10-meter panchromatic resolution. SPOT-2 will be launched this fall. A quasi-private entity, Spotimage, has been created to market the SPOT satellite data. At the same time, the French government continues to be responsible for developing and funding the SPOT satellites. To be judged a success, Spotimage needs only to achieve a commercial return on its data distribution activities.

European governments have also been active in creating organizations to support and promote European space industry. For example, Intospace, a European firm encouraged by the German government, promotes commercial microgravity missions and markets spaceflight opportunities to industry aboard vehicles as varied as the Shuttle and the Chinese Long March retrievable capsule. Novespace is a French firm created by CNES to promote the transfer of space technology to non-space applications in France, while Prospace promotes French space-related industries abroad.

To serve as a focal point for its marketing efforts, the Soviet Union created Glavcosmos. As the Soviet Union's "commercial space corporation," it markets a broad range of Soviet space products, including launch services, flight of instruments on Mir, cosmonaut flight opportunities, and remote sensing imagery.

The Chinese market their launch services and microgravity flight opportunities through the China Great Wall Industrial

Corporation. In addition to their successful efforts to acquire contracts for launching telecommunications satellites, the Chinese have launched small materials processing payloads aboard retrievable flight capsules for the French firm Matra and for Intospace.

Changing Cooperative Relationships

Perhaps more than any other single event, the 1986 encounter with Comet Halley demonstrates the changing context of the international space environment. An armada of spacecraft was sent out to meet Halley; not one of these spacecraft was built in or launched by the United States. Instead, they were individually produced and launched by the European Space Agency, Japan and the Soviet Union. The entire mission was closely coordinated among the partners and benefited significantly from U.S. tracking support and scientific assistance. Still, such a project bridging East and West and undertaken without direct U.S. involvement would have been politically unthinkable and technically unlikely just a few years earlier.

As the number and capabilities of space-faring nations have increased over the past two decades, many new patterns of cooperation have emerged. For example, America's traditional free world partners are seeking larger roles in defining and managing cooperative activities with the U.S. commensurate with their new capabilities. NASA now finds itself not always playing the lead role in joint projects and making different types of contributions than in the past. For instance, in the NASA/ESA Solar Terrestrial Science Program (STSP), which consists of the Solar Heliospheric Observatory and Cluster Mission, ESA is bearing the major share of the cost and is therefore playing the lead project management role. Because NASA gains access to all the science results, and STSP is complementary to NASA's own solar terrestrial missions, we have judged it to be a good deal for NASA.

On the Topex/Poseidon mission, France is providing a free launch with an Ariane for the NASA-built spacecraft with scientific instrumentation from both partners aboard. Up to now, NASA has always borne the responsibility, and the cost burden, for launching its cooperative missions. Now that other nations possess reliable launching systems and are defining their own scientific space missions, NASA can from time to time gain flight opportunities for U.S. scientific instruments at relatively modest cost. For example, NASA plans to fly instruments on two Japanese-developed and Japanese-launched scientific spacecraft, Astro-D and Solar-A in 1991 and 1993.

The new openness of the U.S.S.R with its changing posture toward Western nations means that the traditional cooperative partners of the U.S. have more options for cooperation than in the past,

and the Soviets are actively courting cooperation with the industrial nations of the West. Last year alone, formal overall space cooperation agreements were signed by the Soviet Union with Germany and Italy, and cooperation with the French was expanded. An agreement was also signed with Brazil, and Austria finalized a reimbursable agreement for the flight of an Austrian cosmonaut. Many of the key scientific instruments on the Kvant astrophysics module on the Mir space station were designed and built by Western European countries. Western European countries also participated on the recent ill-fated Phobos missions. France provided several instruments for the spacecraft, as did Germany, Sweden, Austria, Switzerland, and ESA.

It is clear that the ability of the U.S. to control the shape and course of international cooperation is more limited today than in the past. Our partners in cooperative activities, with their increasingly competitive technologies and growing number of options, will in the future be more conscious than ever of seeking cooperative arrangements which are truly mutually beneficial. The best recent example of this changing environment is Space Station Freedom and the cooperative agreements reached for its development and operation (Figures 11 and 12). While the U.S. by virtue of the size of its investment has the predominant role, the other Space Station partners are making substantial investments and will, as a result, be actively involved in management and operation of the Station. This arrangement contrasts sharply with earlier cooperative infrastructure programs, such as the Remote Manipulator System and Spacelab, where the foreign partner developed the hardware with its own resources and technology and then turned the infrastructure over to NASA to own and operate.

Growing Costs Encourage Expanded Cooperation

Periodically, the view is expressed that increased concerns about commercial advantage and national technological competitiveness will diminish the possibilities for and benefits of international space cooperation. Certainly, technology transfer considerations loom large in assessing any cooperative opportunity today. However, NASA has successfully faced the challenge of protecting U.S. technology throughout its long history of international collaborations. In fact, as space-related capabilities and experience expand overseas, NASA's partners are every bit as concerned about protecting their technology and commercially promising ideas as we are. In some cases, this development has eased rather than complicated NASA's negotiations with foreign partners.

On balance, the recognition of the need for cooperation between governments appears stronger today than ever. The major space projects of today and tomorrow are so ambitious and expensive

that they exceed the capabilities and resources of most nations acting alone. International programs on the scale of Space Station Freedom are possible now precisely because of the growing space capabilities and budgets among America's traditional partners.

The current international concern for the changing global environment provides a striking example of an area that must be addressed internationally. The International Space Year, with its "Mission to Planet Earth" theme, will draw intense interest and attention to this key issue and will involve an unprecedented number of nations in cooperative space activities. NASA is already working with its partners on plans to coordinate the observations of spacecraft from the U.S., Europe, Japan and Canada, together with ground-based observations, to provide the necessary data to understand and make informed policy judgements about such issues as global warming and ozone depletion. Recently aroused Soviet interest in environmental protection issues suggests that this could be a particularly fruitful area for U.S.-U.S.S.R. cooperation in the 1990's and beyond.

Finally, U.S. national space policy establishes the expansion of human presence and activity beyond Earth orbit as a major new long-term goal for the United States. Outposts on the moon and expeditions to Mars are inherently ambitious programs requiring great resources and a strong, sustained political rationale. On the eve of celebrating the twentieth anniversary of the Apollo Moon landing, policymakers are beginning to confront this newest American space goal. It is too soon to anticipate how this epic journey will unfold. Perhaps the Space Age which began and spent its early years in a bipolar world of intense Cold War competition is about to witness an explosive era of cooperative planetary exploration involving the talents and citizens of both new and experienced space-faring nations.

Mr. Chairman, this concludes my prepared remarks. I would be pleased to respond to questions.

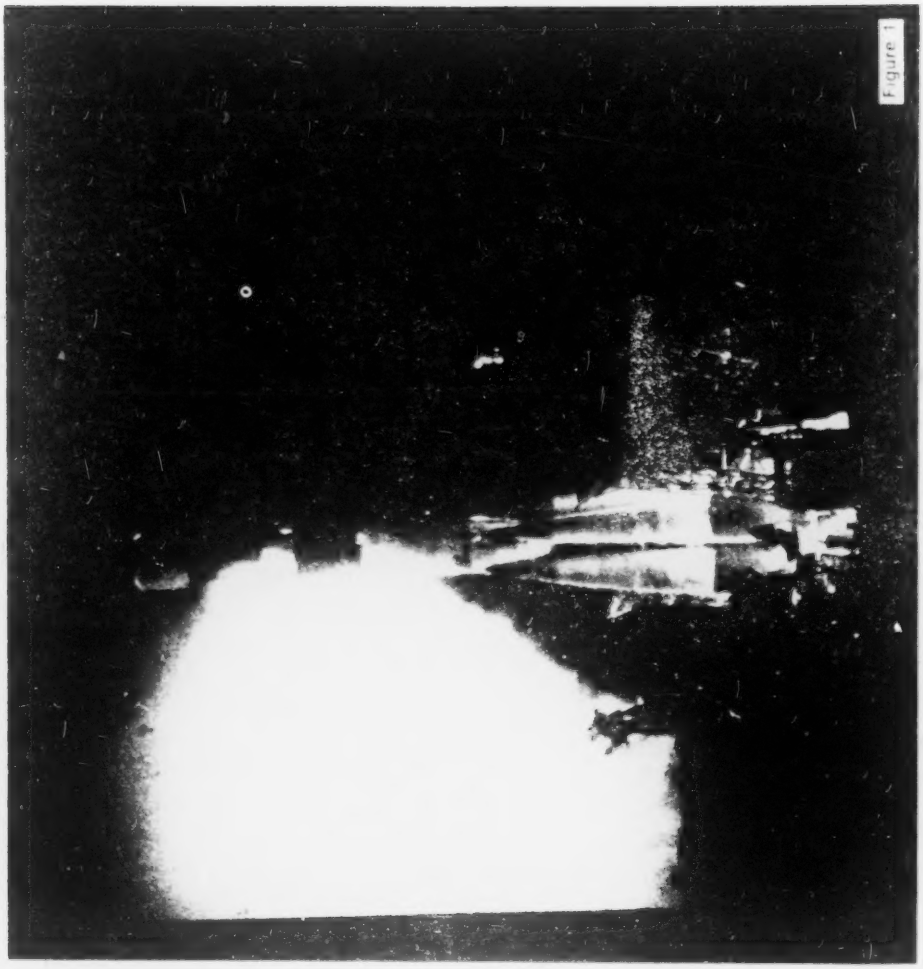


Figure 1

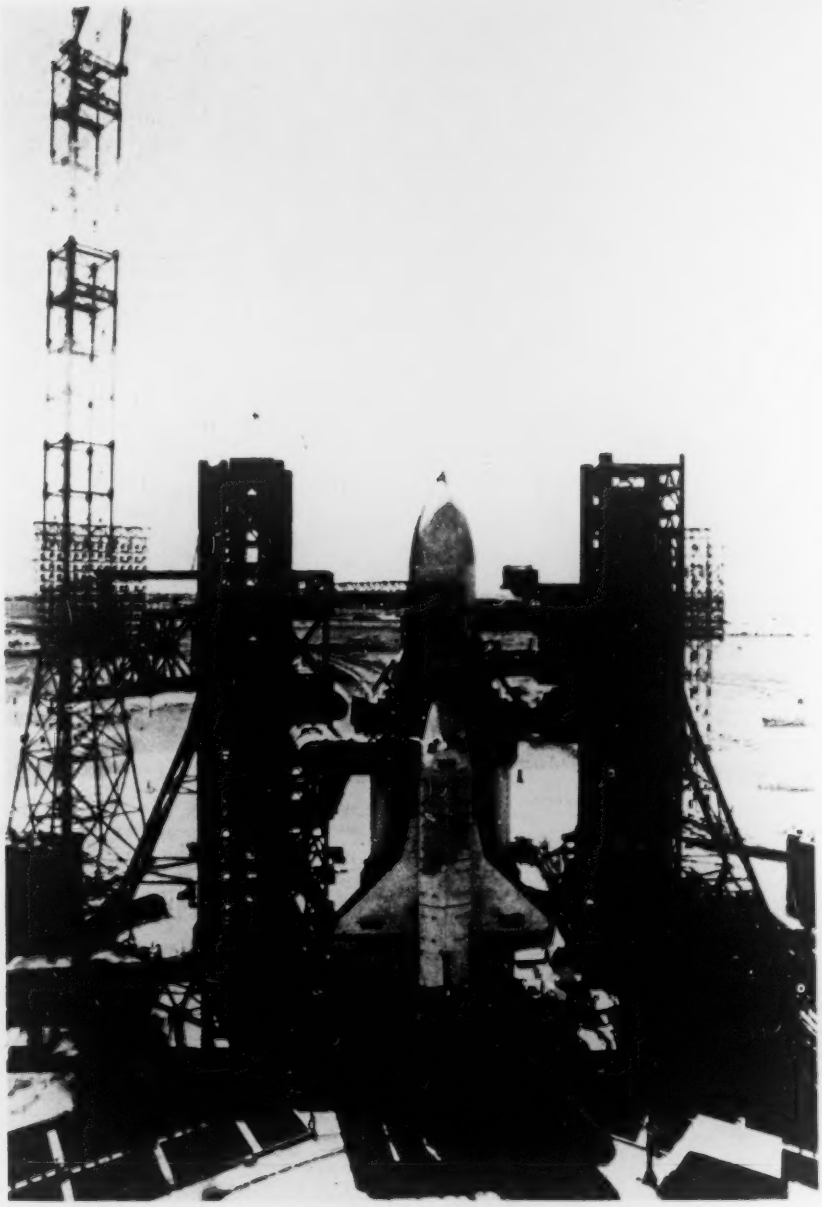
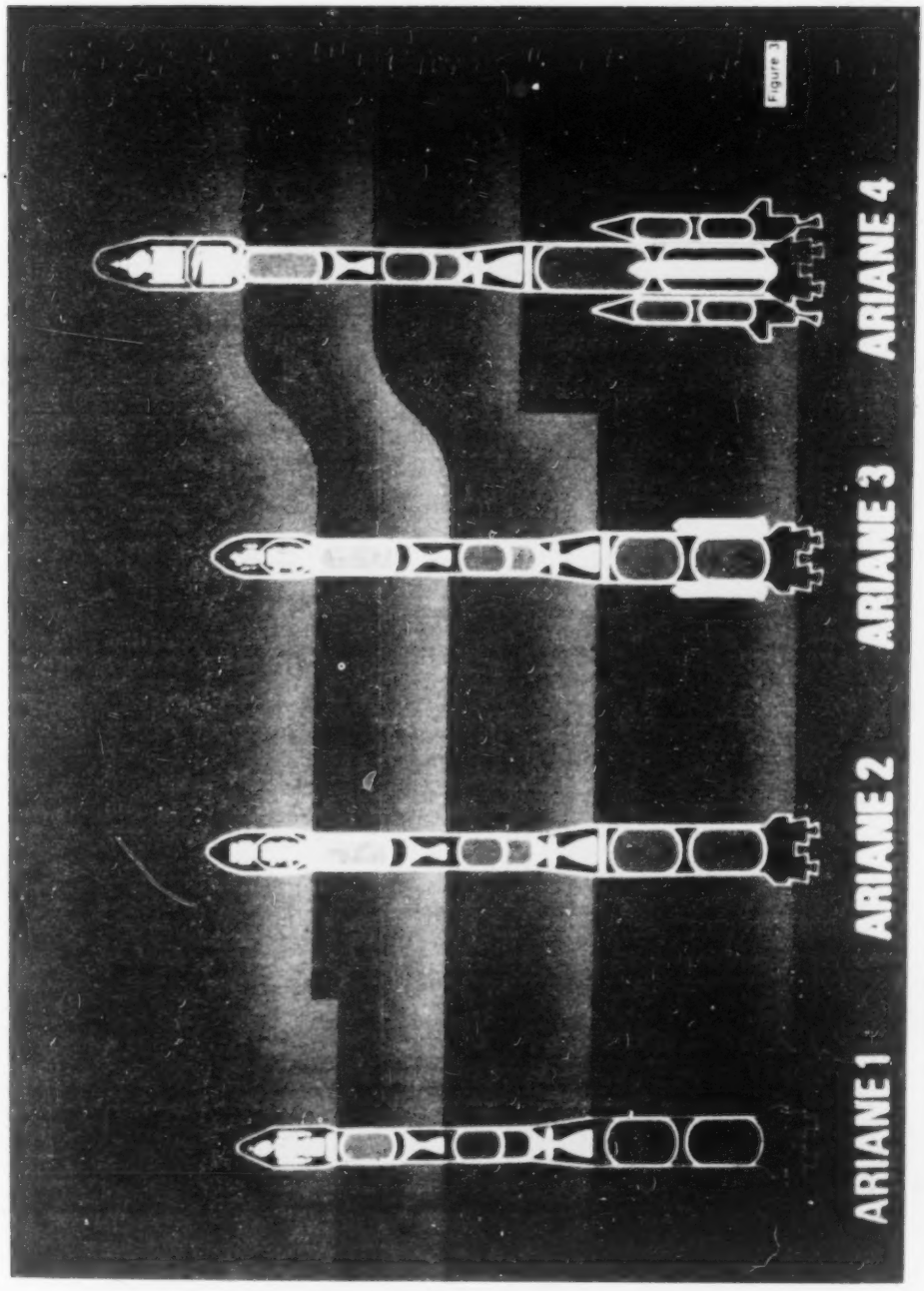


Figure 2


ARIANE 1
ARIANE 2
ARIANE 3
ARIANE 4
Figure 3

The Ariane 5 Launcher

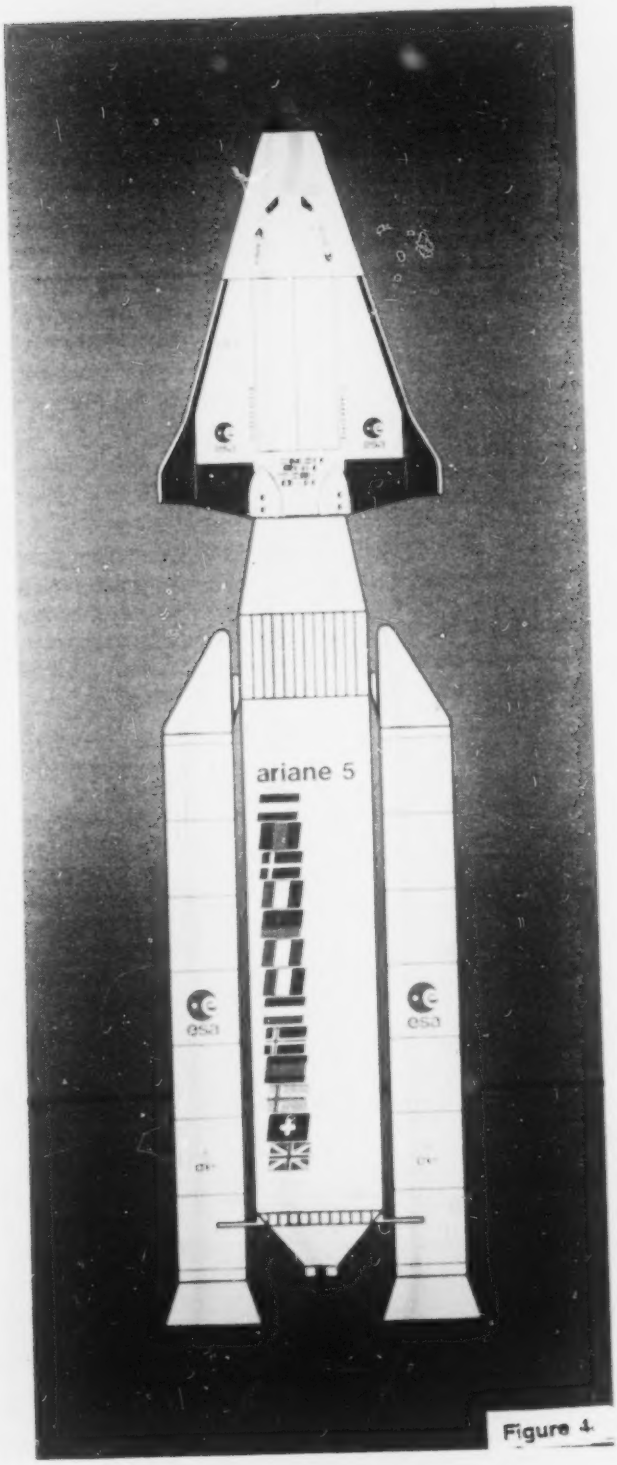
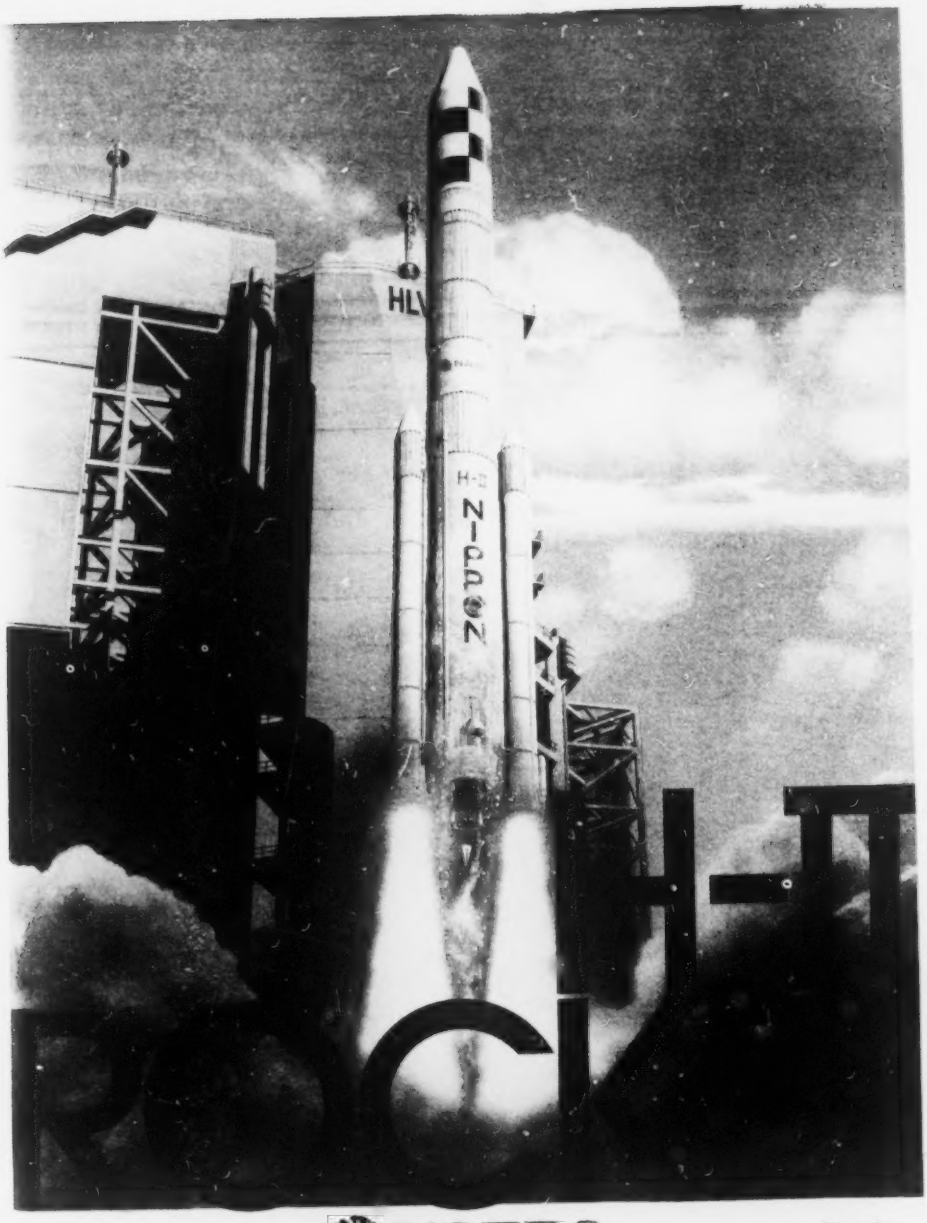


Figure 4



NASDA
NATIONAL SPACE DEVELOPMENT AGENCY OF JAPAN

Figure 5

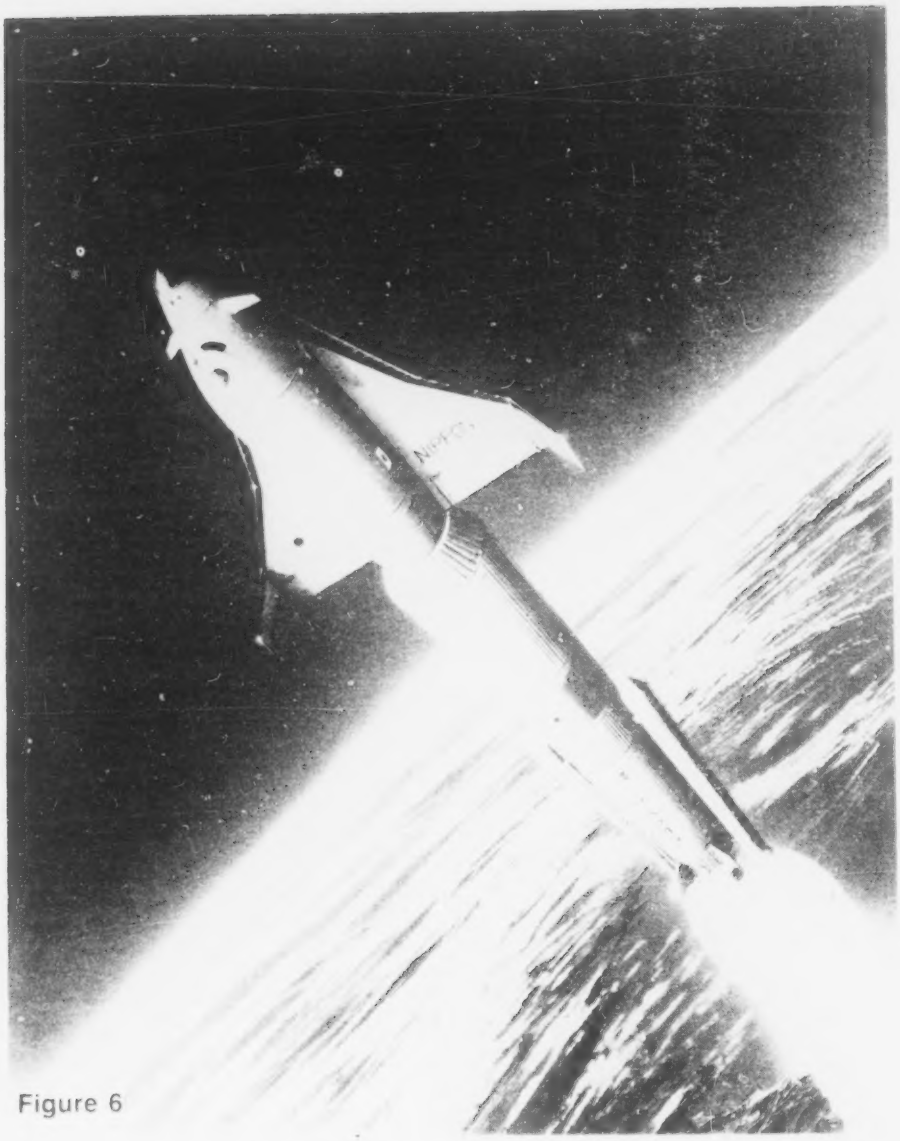


Figure 6

Figure 7

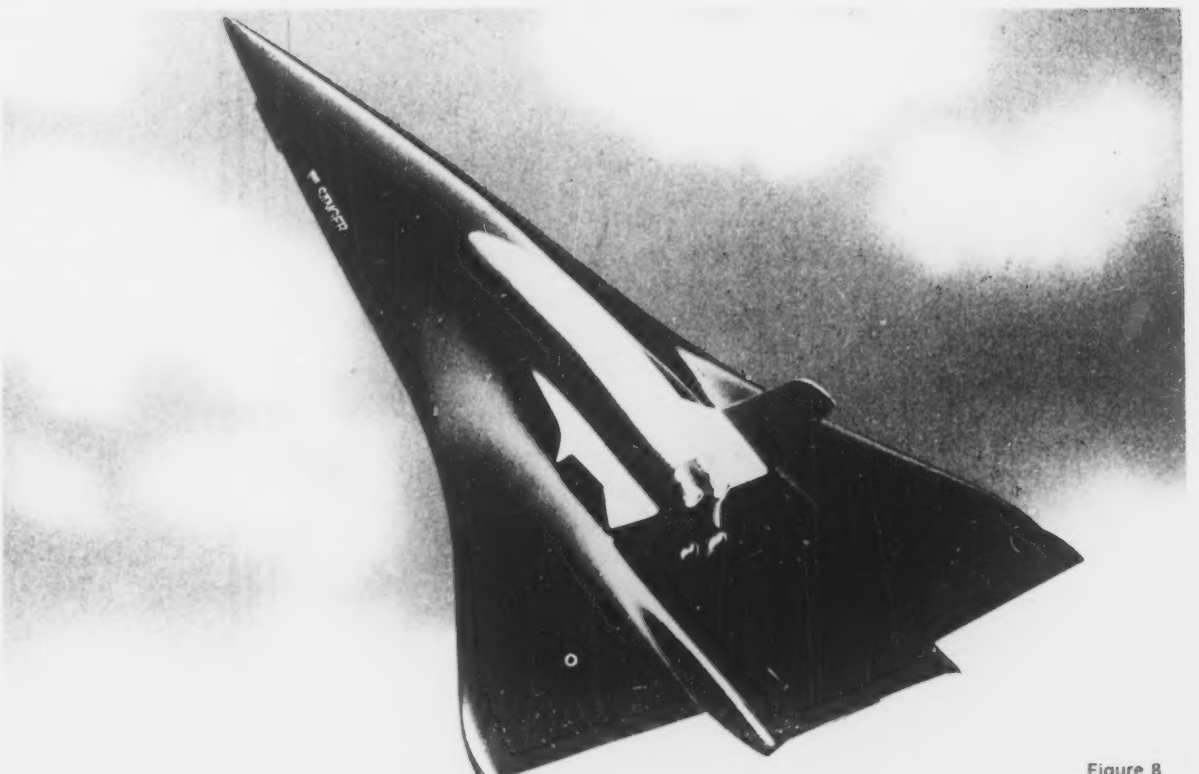
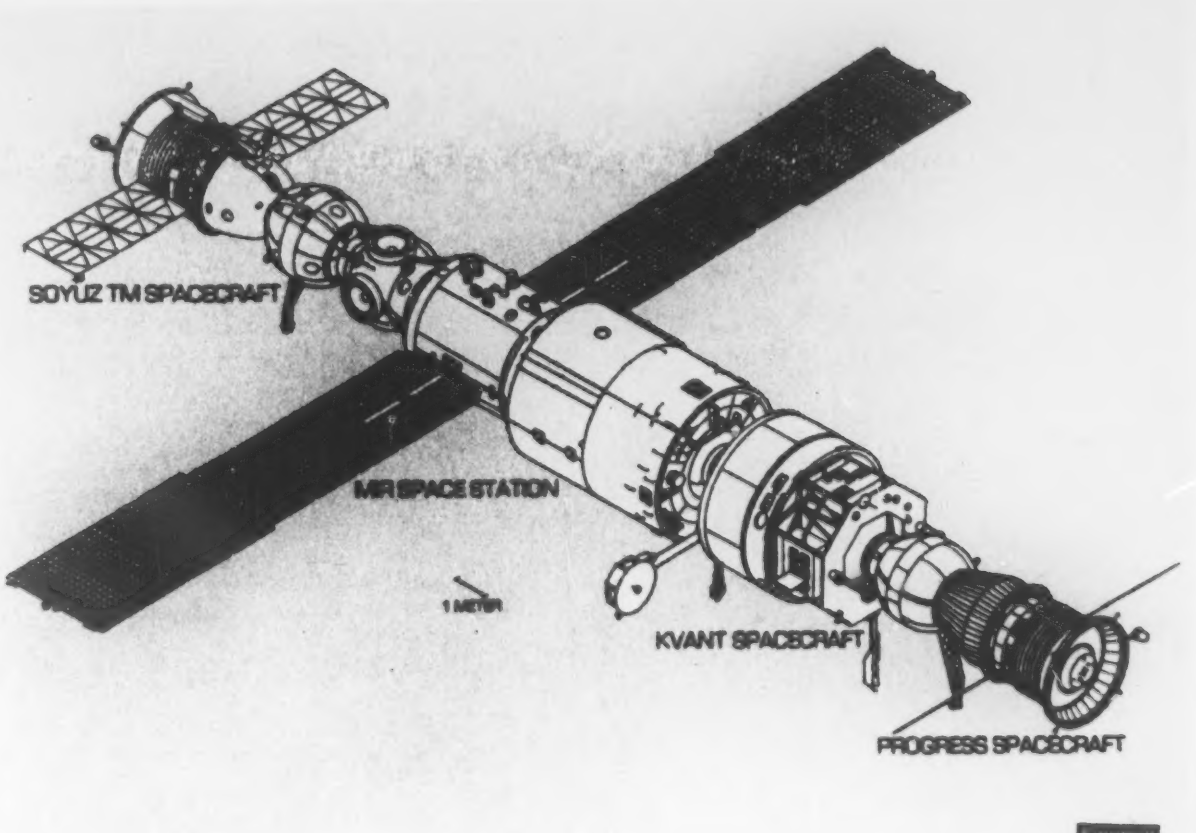


Figure 8

SÄNGER - Wiederverwendbarer, zweistufiger Raumtransporter für Personen und Nutzlasten, der von europäischen Flughäfen jeden gewünschten Erdorbit (LEO) erreichen kann - ein Vorschlag von MBB. / Reusable two-stage aerospace plane for passenger and cargo transport which can reach all Low Earth Orbits (LEO) from European airports - an MBB proposal. Photo: MBB-ERNO; reproduction free of charge. ON 61716-11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MIR SPACE STATION
1 METER
KVANT SPACECRAFT
PROGRESS SPACECRAFT

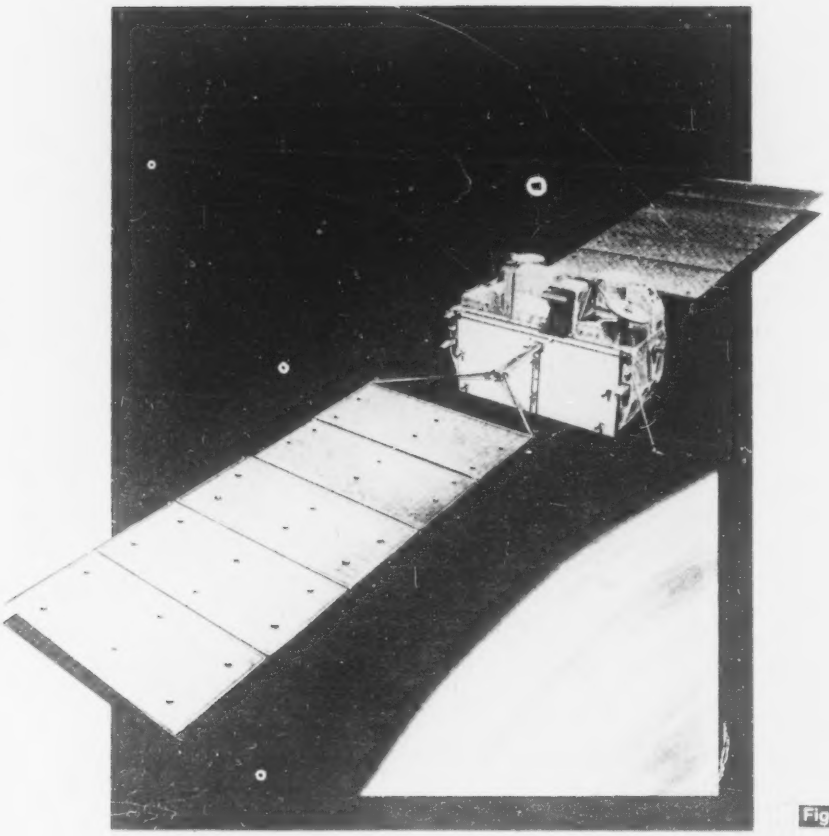

Figure 10

Industrial Platform Operations of EURECA and AMISA

Figure 11

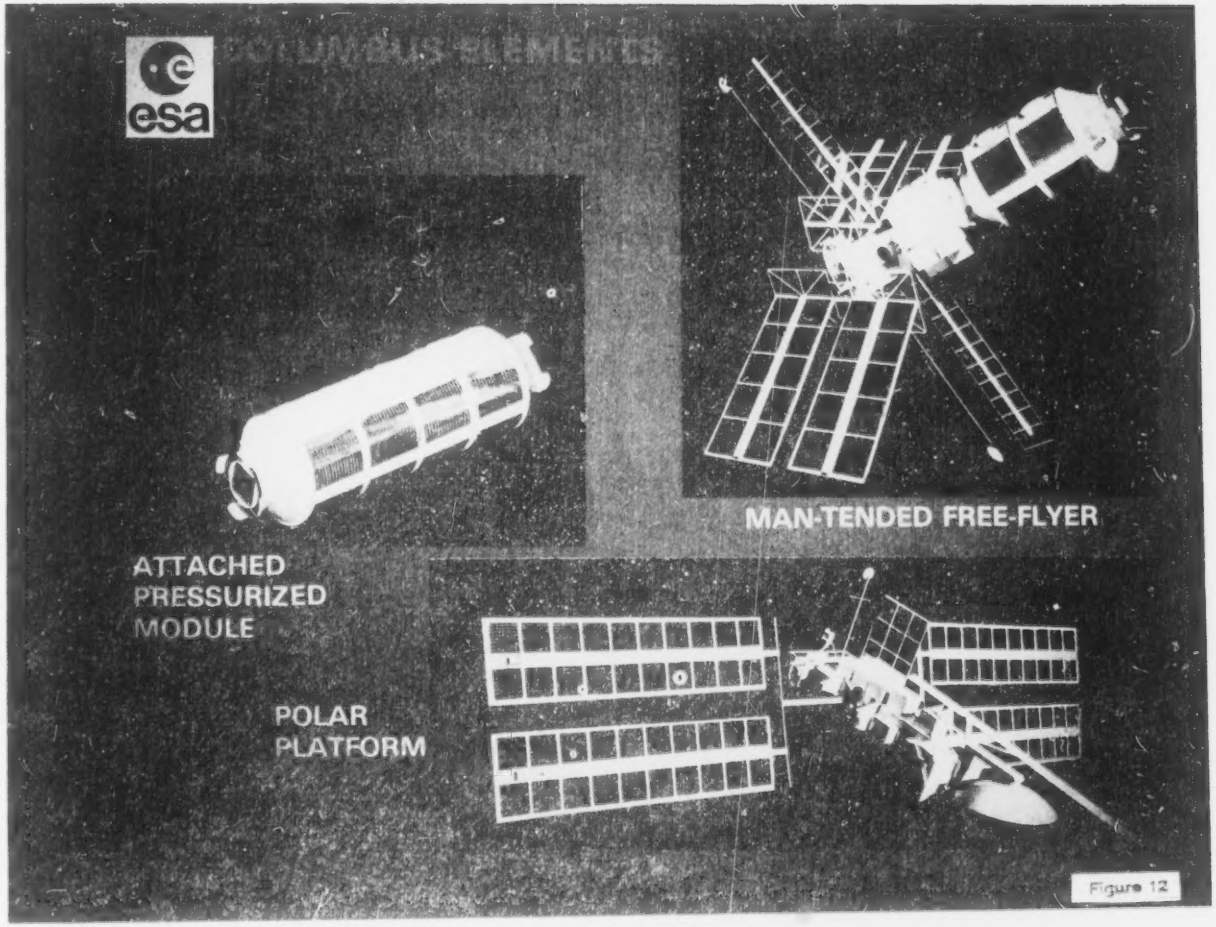
esa
MAN-TENDED FREE-FLYER
ATTACHED
PRESSURIZED
MODULE
POLAR
PLATFORM

Figure 12

Senator GORE. Thank you very much, Mr. Pedersen. Thanks for getting us off to a good start.

Before we go to our next witness, let me acknowledge the presence of our most faithful subcommittee member, Senator Chuck Robb. If he has no statement, we will move right on.

Our second witness on this panel is Mr. Michael Michaud, Director of the Office of Advanced Technology at the Department of State.

Welcome. Please proceed.

STATEMENT OF MICHAEL MICHAUD, DIRECTOR, OFFICE OF ADVANCED TECHNOLOGY, DEPARTMENT OF STATE

Mr. MICHAUD. Thank you, Mr. Chairman. We appreciate your inviting us to speak today. The Department of State maintains a strong interest in the status of the U.S. space program in an international context, and we are an active participant in the National Space Council.

Today I would like to concentrate my remarks on the political dimensions of the question you have raised. My basic message is that while the situation has changed significantly since 1969 and the challenges are much more complex and subtle than they were at the time of that bipolar U.S.-Soviet contest. We are also presented with, I think, an extraordinary political opportunity, an opportunity for U.S. leadership.

The basic change that has occurred since 1969, as you have heard from Mr. Pedersen, is the proliferation of space capabilities to other nations. The United States is not as dominant as it was at the time of the moon landing in 1969. We no longer control access to space for western nations. There is increased economic and commercial competition, as well as political and military competition. And foreign nations, which were once users of our space capabilities, are now providers of those services.

Many of our competitors seek eventual autonomy in their own space capabilities, and this presents a tricky challenge for those designing models of cooperation. It seems to us, Mr. Chairman, that other nations have also concluded that a visible space program is part of being a modern power. Western Europe, Japan and China are recognized space powers today. Other nations, such as India and Brazil, are following the same path.

They know that space programs advance national security, technology development, economic and social progress, and that they can enhance the national image and promote foreign policy interests. They know that space programs are a powerful demonstration of capabilities that could be used for defense.

Space programs symbolize national capabilities, as national air lines once did. They underpin claims to leadership, and they have intangible domestic benefits such as national pride and motivation for education, particularly in science and technology.

What we foresee, Mr. Chairman, is that these motivations for space programs are so powerful that we must expect a further proliferation of space capabilities around the world, and an even more complex environment to operate in in the future. We have recognized this proliferation in space power by our invitation to Western

Europe, Japan and Canada to join with us in Space Station Freedom. They bring important capabilities to bear on that project.

To answer your direct question, Mr. Chairman, where do we stand today, I would summarize it this way. The United States is putting the Challenger tragedy behind us. Our civil space program has new strength in the renewed operations of the space shuttle and in development of the space station.

Our space science program has regained its dynamism, and we are headed into a glorious decade in space science. Our commercial launch industry is off to a good start, though it faces tough competition from Arianespace and from cheap launch services provided by non-market economies. Our satellite industry is still healthy, though it, too, faces rising competition from Europe and Japan.

Meanwhile, the Soviet program, which was once the measure of the U.S. program, has had a mixture of successes and failures. And we are struck by the fact that glasnost in the Soviet Union has brought unprecedented domestic criticism of Soviet spending on space.

Mr. Chairman, though the United States is not as dominant as it was 20 years ago in the space field, there is no doubt in the Department of State that the United States has, overall, the most advanced and diverse civil space capabilities and commercial space capabilities of any nation. We believe that our competitors are well aware of that and are envious of that fact. Other nations wish they had our civilian space program.

A fair question then may be asked, why do we hear so much criticism from our own citizens about our space program? In part this is due to the unprecedented variety of competition we face in the uses of space. Other people are capable of doing things that only we could once do.

But I believe there is another, more subtle reason, which is that Americans have high expectations of their country. They are not content that the United States is simply a competent space power. They want us to define the future agenda; they want us to lead.

Other nations, though they do not want us to impose our views, also expect us to play a leadership role in defining the future agenda for space. They respect our abilities, but they are sometimes puzzled about where we are going. To assert our leadership, we need to tell them.

I would like to emphasize, Mr. Chairman, that space leadership and space cooperation are not mutually exclusive. And in that context I would like to suggest that we are presented with a major new opportunity, a very different situation than that of 20 years ago.

The agenda for the future in space is heavy with macro-projects like the moon base, the Mars mission, the Mission to Planet Earth, in its broad sense of including other nations as well as the NASA program. But our agenda in space overlaps with the agendas of other nations that also have important space capabilities, and they, too, face political and financial obstacles in realizing those agendas.

Because of our strength, we have the opportunity to lead the definition of an international agenda in space and to shape a rational international division of labor in the great enterprises of the future. We have the opportunity to accelerate the space agenda

through intelligently planned international cooperation, taking advantage of the skills and resources of others, as well as those of our own people.

I suggest, Mr. Chairman, that the United States aspire to lead coalitions in these areas of great space achievements in the future. But our willingness to cooperate in those ventures must be matched by our willingness to lead. There will be competition, as well as cooperation, in our space future, and that competition can be healthy in spurring us to new achievements.

I would like to close with a final observation, Mr. Chairman. The United States has made a major investment not only in its civil space program, but also in its national security space programs, and in the encouragement of commercial space programs.

Effective national security space programs are vital to the defense of the United States and its allies, but they are largely classified and limited in their visibility. Commercial space programs can improve our material well-being and our national competitiveness, but they, too, lack the psychological impact of the important civil space achievements.

It is our civilian space program that demonstrates our leadership and our dynamism in a highly visible way, and that enables the United States to be an attractive partner in cooperative ventures. It is the civil space program that gives us foreign policy leverage. Without it, Mr. Chairman, I believe the United States would be a lesser nation today.

Thank you.

[The statement follows:]

STATEMENT OF MICHAEL A.G. MICHAUD
DIRECTOR, OFFICE OF ADVANCED TECHNOLOGY
U.S. DEPARTMENT OF STATE

Before the Subcommittee on Science, Technology, and Space
Committee on Commerce, Science and Transportation
United States Senate

July 19, 1989

Mr. Chairman, thank you for inviting us to testify today on the important topic of the status of the U.S. space program in an international context The Department of State maintains a strong interest in this issue, and is an active participant in the delibarations of the National Space Council.

My colleagues on this panel have given the Subcommittee fine presentations comparing the U.S. civil space program to the space programs of other nations. I would like to concentrate my remarks on the political dimensions of this issue.

Civilian space programs have always been powerful political symbols, and such symbols can increase the influence of nations in world affairs. Our dynamic civilian space program is a demonstration of our scientific ability, technological skill, and cultural daring. Our competence, and our bold vision of what is possible, strengthen the perception that the United States is the most influential shaper of the human future, the nation most worth emulating, the most attractive partner for association and cooperation, and the nation best able to provide high technology goods and services. It also implies military strength that must be respected by potential adversaries.

There are many scientific and technological activities that influence those perceptions. But civil space activities, because of their unique visibility, their impact on public opinion, and their association with transcendental aspirations, remain flagships of the American scientific and technological enterprise.

The Soviets must have sensed this in the early days of the space race, when they exploited a temporary advantage in launch capability to radically change the image the Soviet Union conveyed to the international community. Once considered a backward country, the Soviet Union emerged as a world power, technologically competent and capable of reaching the United States with nuclear warheads.

The United States responded brilliantly to the Soviet challenge of the late 1950's and early 1960's, clearly surpassing Soviet achievements with Project Apollo and a dazzling space

science program, particularly in planetary exploration. This won us great credit in the international community. However, as the visible challenge from the Soviets receded and other priorities placed claims on our national political attention and resources, our relative commitment to civil space programs diminished.

Meanwhile, the Soviet tortoise moved steadily forward with deploying systems in Earth orbit, including a modest space station, and with a space science program that, among other things, scored impressive successes on Venus. The Soviets earned some modest political mileage by flying guest cosmonauts from socialist countries. However, the Soviets suffered in political terms from the relative secrecy that surrounded their space programs. For most nations, the United States remained the most attractive partner for activities in space. An important symbolic turning point was the signing of the Spacelab agreement with Europe in 1973.

Western European nations took an important step toward autonomy in the development of the Ariane series of launch vehicles, and Japan has pursued a similar course. This has reduced their dependence on the United States for launching unmanned spacecraft, but it is still only the United States and the Soviet Union that have manned spaceflight capabilities.

The Space Shuttle, after it first flew in 1981, gave us a significant advantage in the political symbolism of space. Giving us new flexibility in the uses of space, looking vaguely like an airliner, carrying large crews in relative comfort -- sometimes including foreign astronauts -- the Shuttle reconfirmed the widespread belief in American competence on the space frontier.

That belief in our competence helped attract Western European, Japanese, and Canadian participation in the Space Station project, announced by President Reagan in January 1984. In effect, our allies have tied their futures in manned spaceflight to ours for a generation. This is a remarkable political achievement, made possible by the repeated public demonstration of our vision and ability in the uses of space. The United States also gave new emphasis to encouraging commercial activity in space -- activity that can strengthen the public image of the United States as the world's leader in space as well as bring economic benefits to the nation.

The Soviets realized that they must adapt if they were to have any hope of competing with us in the political and commercial uses of space. In 1985 they created a new organization, Glavkosmos, bringing together their version of civil space activity with new efforts in space commercialization. The tragic Challenger accident of January 1986, which effectively shut down the U.S. manned space program for two and a half years, gave the Soviets a temporary opening. They launched a space cooperation offensive and a marketing effort for their launch services. They opened parts of their space program to more

public view, notably during the encounters with Halley's comet in the spring of 1986. They have continued this initiative through the present day, boosting their prestige and causing more nations to look to Moscow in space, though they have been largely unsuccessful in selling their commercial services.

Other nations also concluded that a visible space program is part of being a modern power. Western European nations -- particularly France -- made a significant effort to become acknowledged players in the space field. Japan and China also have developed significant space capabilities, and China has entered the world market for commercial launch services. Increasingly, we are seeing a proliferation of space capabilities to other nations such as India, Brazil, and, most recently, Israel.

Those space capabilities have their practical applications, such as communications, meteorology, Earth observation, and navigation. But there are other motivations for emerging space programs: national security, space as a strategic technology sector, space technology as a development tool, and space programs as a means of enhancing the national image and advancing foreign policy interests. Many space technologies have a dual-use character; they can be used for both civilian and military purposs. They can increase national independence of action.

Space technologies are a peaceful demonstration of capabilities that could be used for defense. They symbolize national capabilities, as national airlines once did. They underpin claims to leadership. And they have intangibele benefits, such as national pride, and motivation for education. Such motivations are so powerful that we must expect a further proliferation of space capabilities.

Where are we today? We have put the Challenger tragedy behind us. Our civil space program has new strength in the renewed operations of the Space Shuttle and in the development of the Space Station. Our space science program has regained its dynamism. Our commercial launch service industry is off to a good start, though it faces tough competition from Ariane and from cheap launch services provided by non-market economies. Our satellite industry is still healthy, though it too faces rising foreign competition.

Meanwhile, the Soviet program has seen a mix of successes and failures. The Soviets deployed a heavy lift launch vehicle and a space shuttle that looks much like our own. But they also suffered an embarrassing failure of both of their Phobos probes to Mars. Glasnost and Perestroika have brough unprecedented domestic criticism of the cost of the Soviet space program.

The biggest change is in the proliferation of space capabilities beyond the United States and the Soviet Union. Other nations have become significant players, a fact that we recognized when we invited Western Europe, Japan, and Canada to

join us in the largest cooperative international science and technology project in history -- the Space Station.

Though the United States is not as dominant in the space field as it was twenty years ago, there is no doubt in the Department of State that the United States has, overall, the most advanced and diverse civil and commercial space capabiliites of any nation. We believe that our foreign political and commercial rivals are well aware of this.

Why, then, is there widespread criticism from our own citizens? Why do they express unease about our future in in space? In part, this is due to the unprecedented variety of competition we face, not just in a race to achieve a particular goal, but across the full range of space activity. However, there also is a more subtle reason. Americans have high expectations of their country. They are not content that the United States be just a competent space power. They want us to define the future agenda for humanity in space. They want us to lead.

Other nations, though they do not want us to impose our views, also expect us to play a leadership role in defining the future agenda for spaceflight. They respect our abilities, but they are sometimes puzzled about where we are going. To regain that sense of leadership that we once enjoyed, we need to tell them. We need to define an agenda for the longer-term future.

Leadership in space does not require that we do everything in splendid isolation. Our agenda in space overlaps with the agendas of other nations. They too face political and financial obstacles in realizing their space agendas. Because of our strength, we have the opportunity to lead the definition of international agendas for space, and the shaping of a rational division of labor in the great enterprises of the future. There is implicit in this an opportunity to to accelerate the space agenda through intelligently planned international cooperation, taking advantage of the skills and resources of others as well as our own.

Our willingess to cooperate in these ventures must be matched by our willingess to lead. There will competition as well as cooperation in our space future, and that competition can be healthy in stirring us to new achievements.

Mr. Chairman, I would like to close with a final observation. The United States has made a major investment not only in its civil space program, but also in its national security space programs and in the encouragement of commercial space programs. Effective national security space programs are vital to the defense of the United States. Commercial space activities can improve our material well-being. But it is our civilian space program that demonstrates our leadership and dynamism in a highly visible way, and that enables the U.S. to be an attractive partner in cooperative ventures. It is the civilian program that enables us to be proud. Without it, the United States would be a lesser nation today.

Thank you, Mr. Chairman.

Senator GORE. Thank you very much.

We will hold off on questions again until the panel has completed all three statements. And our third witness, and final witness on this panel, is Marcia Smith, a Specialist in Aerospace Policy with the Science Policy Research Division at the Congressional Research Service of the Library of Congress.

And, Ms. Smith, I would like to personally thank you and CRS for your comprehensive study of the Soviet space program and for the fine work that you all have under way there. Please proceed with your statement.

STATEMENT OF MARCIA SMITH, SPECIALIST IN AEROSPACE POLICY, SCIENCE POLICY RESEARCH DIVISION, CONGRESSIONAL RESEARCH SERVICE, LIBRARY OF CONGRESS

Ms. SMITH. Thank you very much, Mr. Chairman.

I am delighted to be here today to talk about the comparative stance of the U.S. space program with those of other countries in the world. It does seem that wherever I go, inside or outside the Beltway, the first question that people ask me is, who is ahead in space? And by that they usually mean, who is ahead, the United States or the Soviet Union?

As you and my fellow panelists have pointed out, it has long since ceased to be just a bipolar world where the U.S. and the Soviet Union are sending satellites into space; and so the mere fact that there are so many countries involved in space complicates the answer to who is ahead. But even without them, it is a very complex issue to deal with.

Who is ahead in what—in space science, space applications, military space activities, in sending humans into space, in the technology required to do each of these things? The answer to who's ahead can be different for each of those areas.

It is also a question of what arena you are talking about—economic competitiveness, national prestige, or national defense. The answer can be different in each of those as well. What measure are you using for leadership, and what is the prize being sought in the leadership contest? So you have to talk about all of these variables when you are trying to answer what seems to be a very simple question of who is ahead.

In the studies that we have done for your committee on Soviet space programs, we tried to look at each of the different areas of space and tried to make this kind of assessment about U.S. and Soviet space activities. But in the short time I have today I thought that I would focus on what I find always to be of most interest to the American people, and that is who is ahead in sending humans into space. And it seems particularly appropriate this week as we are celebrating the twentieth anniversary of the Apollo landing on the moon.

Who is ahead in sending humans into space? Well, it is a two-part answer. The United States is ahead; that is, if what you are interested in is technology. The United States is clearly ahead in the technology of space generally, and particularly in the area of sending humans into space with our space shuttle. The Soviets have flown a space shuttle, but they have flown it only once, and it

did not have a crew aboard at the time. And it seems this is not a very high priority for their space program. They have said that they will not fly their shuttle again until next year, and again it will be without a crew; and they will not make the first flight with a crew until 1992.

But the other part of the answer is that the Soviet Union is ahead; they are ahead in the operational use of people in space. The measure that is often used for this is the cumulative hours in space that each country has accumulated over time, and today the Soviet Union has three times as many hours in space as the United States.

This is a measure mostly of experience, of how long they have had people up in space doing experiments, fixing space stations. They have an advantage in knowing what people are good for in space and where machines might be better suited to a particular role.

There are a lot of people who have the impression that the Soviets got this leadership advantage over us because of the Challenger tragedy and the 32 months that we did not launch space shuttles; but in fact, the Soviet leadership has developed over a long period of years and actually started in the late 1970s.

In my written statement I have a series of slides that show the evolution of piloted space flight with both the U.S. and the Soviet Union, that shows how it is that it has come to pass that in 1989 the Soviets have this leadership advantage. In brief, the United States made a policy decision in 1975 at the end of the Apollo program that we were not going to launch any people into space until the space shuttle was ready.

We could have continued to launch Apollo crews. We could have launched the backup Skylab space station. But it was a U.S. policy decision not to do that. At that time, during the six-year period when we launched no one into space, the Soviets had gotten their second wind after some setbacks in the early 1970s, and they redoubled their efforts in their space station program. In 1977 they launched the first of their second generation space stations that allowed them to keep people in space for ever increasingly longer periods of time, up to 185 days during that period.

At the end of the Apollo era in 1975, the United States had twice as many hours in space as the Soviet Union, but just five years later, in 1980, the statistic had reversed, and the Soviets now had twice as many hours as the United States. So when the first space shuttle flew in 1981, we were already at a considerable disadvantage compared to the Soviet Union, and although we had 24 very successful shuttle flights before the Challenger tragedy and we have had four successful flights since then, since the shuttle can stay in orbit for only 10 days at a time, we really did not have an opportunity to begin to close the gap in this statistic.

The Soviets, meanwhile, have continued their space station program, and on the Mir space station, which is the first of their third generation stations, they have increased the duration up to 366 days, a year, an entire year for one crew. So during the 1980s the gap between cumulative hours in space has expanded in favor of the Soviet Union.

Based on the analyses we have done for your committee, I do feel that this area of operational use of crews in space is the only area where the Soviet Union has a conclusive lead over the United States. But it does seem to be an area of considerable interest, both in Washington and out in the rest of the country.

There seem to be a lot of people in the space community today who would like to try and stir up another Sputnik fever in the hope that it would give some impetus to the U.S. space program, and so they often turn to this question of who is ahead as a means of stimulating debate. But there is a real question as to whether or not you want to use something like this as the basis for making policy decisions, because leadership is so transitory; it changes hands over time. The Soviets were ahead in 1961 when they launched Yuri Gurgarin into space, but then during the 1960s and 1970s the United States took leadership, and now it has passed back to the Soviet Union.

It does seem that there are perils involved with using this "Who is ahead?" question as a basis for space policy, as was demonstrated earlier this year when the Soviets decided not to send the replacement crew up to the Mir space station. Those people who had premised their support of a U.S. space station on the fact that the Soviets had a permanent presence in space, had their argument undermined by the fact that the Soviets no longer had any crew in space.

It also seems that as time progresses and as more and more countries become spacefaring, that cooperation, rather than competition, is going to be the watchword for the future. The only area in which "who is ahead" may be important in the future is in economic competitiveness rather than in areas of national prestige and national defense. So perhaps the question of who is ahead will fade into obscurity as time passes and more and more countries join the space club.

Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF MARCIA S. SMITH

SPECIALIST IN AEROSPACE POLICY
SCIENCE POLICY RESEARCH DIVISION
CONGRESSIONAL RESEARCH SERVICE
LIBRARY OF CONGRESS

Mr. Chairman, thank you for inviting me to testify today on the comparative aspects of the U.S. space program with space activities around the world. As the country celebrates the 20th anniversary of the Apollo 11 landing on the Moon, it is indeed appropriate to look at our program and where it stands in relationship to the rest of the world.

Americans constantly seem tempted to compare our program with that of our historic rival, the Soviet Union. Indeed, the "space race" with the Soviets was an integral part of the early years of our space program. Today, answering the question of "who's ahead" is much more difficult. Not only is neither the United States nor the Soviet Union THE leader in space, but they have long since ceased to be the only players. There are quite a few spacefaring countries in 1989, the exact number depending on the criteria used to define "spacefaring."

My first chart lists total launches through the end of 1988 by the world's "launching countries," the six spacefaring countries and one international organization capable of launching their own satellites--the United States, Soviet Union, Japan, China, India, Israel, and the 13-nation European Space Agency. The second chart is a time-line comparing the first year each of these countries achieved its first successful launch. As you can see, throughout the 32-year history of the space program, countries have tried and succeeded in "joining the club." The motivations for each of these countries in developing a launch capability is different. While national prestige certainly plays a role in all the programs, military security is at least as important for all but Japan and ESA, where autonomy seems to be the primary driver.

My third chart shows another way of counting "spacefaring countries," that is, countries whose nationals have flown in space. Only the United States and Soviet Union have the ability to put people into space, but each has invited representatives from other countries to travel into space with them. By this count, there are 20 spacefaring countries. In a broader sense, however, virtually every country in the world is spacefaring since they routinely use satellites for communications and weather forecasting. The 114 members of the International Telecommunications Satellite Organization (Intelsat) and the 15 members of the Soviet alternative, Intersputnik, could all be considered spacefaring, for example.

Because of their historic rivalry and their superpower labels, public attention remains concentrated on the United States and Soviet Union. Three decades into the Space Age the question still most often asked is "who's ahead?" I would like to make this topic the focus of my remarks this afternoon since there seems to be so much confusion on this point.

Dozens of newspaper and newsmagazine articles, and quite a few people in the space community, portray the Soviet Union as having "surged" ahead after the 1986 space shuttle Challenger tragedy to where it is now 10 years ahead of the United States in space. But there are many facets to space programs, and the answer to "who's ahead" can be different for each activity--space science, space applications (military and civilian), operational activities involving crews, and technology for each of these areas. There are also different kinds of competition: economic, military, and national prestige. Determining "who's ahead" requires specifying what type of space activity is being measured and what kind of prize is being sought. It also requires a benchmark against which to judge the contest.

National prestige still engenders the most emotional debate about "who's ahead" in space. Based on the analysis we did for your committee in *Soviet Space Programs 1981-1987 (Parts 1 and 2)*, I am convinced that there is only one area where the Soviets conclusively have the lead--operational use of crews in Earth orbit, and this leadership developed in the 1970s, before the first U.S. shuttle was even launched.

Some would argue that the Soviets have a leadership advantage in launch vehicles, with their diverse and robust fleet, but it is a mixed blessing at best for them. They require a large number of launch vehicles and high launch rate because their low-technology satellites need to be replaced more often than Western satellites. Maintaining the production base and launch teams for 100 launches per year must pose an economic drain on the space program. On the positive side is the fact that in a military crisis, they have a surge capability to launch many satellites in a short period of time. They have recently introduced a new heavy lift launch vehicle, Energiya, that is reminiscent of the old U.S. Saturn V. Thus, they do have an advantage in terms of lift capacity, but they apparently do not have many payloads that require it. At a recent meeting in Washington, the designer of Energiya was asked what payloads they planned to fly on the vehicle and he jokingly responded that finding payloads was exactly the reason he was in the United States! Thus, Energiya itself is a mixed blessing for them. Meanwhile, the United States is returning to a "mixed fleet" policy and deciding whether or not it needs a heavy lift launch vehicle for use in the 1990s and beyond. In short, both countries have developed the launch vehicle fleets that they need to support their particular space activities. In this context, neither can be said to be "ahead" of the other.

Programs that involve putting humans in space generate great visibility around the world, and therefore are the ones for which most people want to know "who's ahead." But the answer depends on the frame of reference. The United States is ahead in the technology, since the Soviets still do not have an operational space shuttle (they have flown their's only once, and without a crew). The Soviet Union is ahead in operational use of crews in Earth orbit

where they have a three to one advantage over the United States in cumulative hours in space. This advantage did not develop in 1986 because of the Challenger tragedy, but because of policy choices made by the two countries in the 1970s.

The statistic of cumulative hours in space can be used as a measure of leadership because it shows a level of experience attained both in operating a space facility, and in conducting experiments. The Soviets have made major repairs to their space stations, inside and out, and they have conducted wide ranging research in astronomy, biology (human and plant), earth resources, and materials processing. They have learned what things people do well in space and what they do poorly and can better be accomplished using automated systems. Through long duration missions, they have begun to establish a medical basis on which to determine whether humans can travel to Mars, an announced goal of the Soviet space program. Through hundreds of experiments in materials processing, they have formed a basis for deciding whether to proceed with another goal, forming space industrial parks where materials will be produced for use on Earth. They simply have had more time to answer some of the basic questions that must be resolved in order to meet their space goals.

The Soviets have not always been ahead in the operational use of crews, but rather leadership has shifted back and forth between the superpowers. It might be useful to briefly review the development of piloted spaceflight since that day in 1961 when humans first stepped off Planet Earth. I have five charts here that present a time-line of U.S. and Soviet space missions that have carried people into space.

It all began on April 12, 1961, when the Soviets launched the first man into space, Yuriy Gagarin. This stellar accomplishment came at a bad time for the United States. We had just elected young, charismatic John F. Kennedy as President and he had immediately run into the Bay of Pigs incident, which placed America in a negative international light. Then, to add to his problems, the Soviets once again grabbed the technological brass ring by putting a human into space. To begin recouping American international prestige, just three weeks after Gagarin's flight, the President approved the launch of Alan Shepard, who became the first American in space (although he did not go into orbit as had Gagarin). Just three weeks after that, with only Shepard's flight as experience, President Kennedy came before Congress and called upon the Nation to commit itself to the goal of landing men on the Moon before the end of the decade. The Moon Race was on. During the next two years, the United States carried out the Mercury program of six flights, and the Soviets conducted their similar Vostok program. Both flight programs were designed to show whether people could, in fact, survive and function during spaceflight. The answer was an emphatic yes.

By 1963, the two countries had reached an equal footing in this arena--neither was a leader. Over the next two years, the United States conducted the Gemini program of 10 flights to demonstrate rendezvous and docking in Earth orbit, because we would have to do it in lunar orbit; to extend the duration of spaceflight to an amazing (at the time) 14 days; and to experiment with extravehicular activity, or spacewalks. The Soviets, by comparison, launched only two piloted missions, Voskhod 1 and 2. Using the same spacecraft as they had for the Vostok program with a different internal layout, they achieved two more space "firsts": the first multiple crew on Voskhod 1, and the first spacewalk on Voskhod 2--slim offerings from the country that only a few years earlier had been the undisputed leader. By the end of Gemini, the "leadership" had reversed, and the United States was clearly ahead.

In 1967, both programs came to a tragic halt. On January 27, 1967, our three Apollo astronauts were killed in a fire at Cape Kennedy during a pre-launch test of the first Apollo mission. Just three months later, on April 24, the pilot of the first Soviet Soyuz capsule was killed upon impact with the Earth when the spacecraft's parachute lines tangled during descent. Both programs were set back by a year and a half.

I might comment here, Mr. Chairman, that there is a misconception among almost everyone I meet that the Soviets are callous regarding their cosmonauts and care little if a few die in pursuit of space goals. In fact, the record shows that they respond much as we do. In this first case of losing a cosmonaut, they shut down their piloted space activities for 18 months, almost identical to the 21 months that the U.S. program was halted.

When flights resumed in the fall of 1968, it was clear that the United States was still ahead. The first launch following the Apollo fire was a full-up test of the Apollo command module in preparation for the December 1968 mission when three astronauts spent Christmas in lunar orbit. For the Soviets, their first post-Soyuz 1 flight was a simple rendezvous between two Soyuz spacecraft, one with a pilot, the other without.

By July 20, 1969, when America formally won the Moon Race, the United States was far ahead in the use of crews in space, a leadership position we maintained throughout the early 1970s. The Soviets, unable to develop a launch vehicle with the capability of Saturn V, turned their attention to Earth orbit, and although they launched the world's first space station, Salyut 1, in 1971, their program was plagued by problems and tragedy during this period. The first crew to successfully occupy the space station was killed during reentry when they failed to properly close a vent and their cabin atmosphere escaped into space. They were not wearing spacesuits, since the Soviets were confident of their technology and the Soyuz spacecraft of that era could not accommodate three space-suited cosmonauts, and the three men were

asphyxiated. The Soviets did not launch another crew into space for 27 months, not that much different from the 32 months we waited after the Challenger tragedy.

Meanwhile, the United States was completing the very successful Apollo lunar program (although we had another near tragedy on Apollo 13), and we launched our first space station Skylab, to which three crews were sent in 1973 and 1974. During the Skylab era, we extended the duration of spaceflight up to 84 days, a record that went unbroken for five years. Although the Soviets successfully operated two more space stations, Salyut 3 and 4, they had mixed success, and perhaps more importantly, two other space stations, Salyut 2 and Cosmos 557, failed before they could be occupied.

By the end of the Skylab program in 1974, the United States had twice as many cumulative hours in space. How then did we reach the point where we are today with the Soviet Union having three times as many hours as the United States?

Following the 1975 Apollo-Soyuz Test Project, where American astronauts docked with Soviet cosmonauts for two days of joint experimentation in Earth orbit, the United States ceased launching humans into space for six years, waiting for the space shuttle to come along. The Nation decided that launching people into space was not a good investment at that time. The decision could have been made to launch the backup Skylab, which today is a tourist attraction at the Air and Space Museum, and to continue manufacturing Apollo capsules and Saturn launch vehicles. But the policy decision was no, let's wait for the space shuttle.

The Soviets, conversely, had gotten their second wind. Following work with Salyut 5, the Soviets launched a second-generation space station in 1977, Salyut 6. Because this design had two docking ports, the Soviets were able to send up cargo ships to bring food, water, air, and most importantly, fuel, to the space station, allowing it to continue operating for six years. During the Salyut 6 era, the Soviets incrementally increased the duration of spaceflight to 185 days. By the end of 1980, the statistics had reversed: the Soviets had twice as many hours as the United States.

So by 1981, when flights of the U.S. space shuttle began, the United States was already far behind the Soviets in operational experience in Earth orbit. Although we had 24 very successful flights of the space shuttle before the Challenger tragedy in 1986, and have had four more shuttle missions since the return to flight last fall, the shuttle can only stay in orbit for up to 10 days at a time. Salyut 7, launched in 1982, continued the success the Soviets have had with the space station program and extended duration to 237 days. In 1986, a new third generation space station, Mir (Peace), was launched, and cosmonauts have stayed aboard for up to 366 days.

In summary, these charts show that:

- Soviet leadership in the operational use of crews in space developed over a period of several years during the late 1970s, not suddenly in 1986 because of the Challenger tragedy;

- if the United States wants to compete with the Soviet Union in this arena, it must invest in a space station of its own (assuming the Soviets do not suddenly terminate their space station program); and

- leadership is not constant, but changes hands over time.

It seems unfortunate that 32 years after the launch of Sputnik sparked a "space race" between the superpowers that space activities are still so often characterized in those terms. The world today is very different from that of the late 1950s and early 1960s. As noted, the United States and Soviet Union are no longer the only players, and cooperation, not competition, increasingly is the watchword of space programs.

Nevertheless, "beating the Russians" is the battle cry of legions of space enthusiasts, despite the risks associated with choosing such a subjective and transitory phenomenon as a rationale for the U.S. space program. Its perils were demonstrated this spring when the Soviets decided, much to the surprise of Western analysts (and the Soviet cosmonaut corps), to leave the Mir space station vacant for a while, undermining the arguments of those who premised their support for the U.S. space station on competing with a permanent Soviet presence in space. If the Soviets do not have a permanent presence in space, is there no need for a permanent American presence? If they decide to cancel their space station program entirely, is there no justification for a U.S. space station? If the Soviets rescind their goal of sending humans to Mars, is there no reason for the United States to choose that goal?

Basing U.S. decisions on what the Soviets are doing is particularly hazardous today, because the situation is so fluid there (as demonstrated by the Mir decision). A year ago, a Western analyst might have sat here and argued that another area in which the Soviet Union was convincingly ahead was "commitment" to its space program. Historically, the Soviet space program has not been subjected to the vacillations in support characteristic of the U.S. program. But the last few months have seen a dramatic surge of public questioning by Soviet citizens and politicians of the wisdom of spending on space activities. What changes ultimately may be wrought because of *glasnost* and *perestroika* are impossible to predict, but Soviet President Gorbachev has made clear that no area of spending is sacrosanct. Whether the Soviets will reassess their goal to send humans to Mars, and with it the

need for long duration space station missions, is an open question. What is clear is that they are vigorously seeking international cooperation, and not only from the United States, but from Europe and Japan as well.

Although it seems inevitable that countries will use space as a method of engendering national pride, a prime motivation for racing with each other, the allure of international cooperation is receiving increasing attention as every country wrestles with economic problems. Countries can accomplish more through cooperation where costs are shared among several partners, and there are quite a few potential partners today. In the not too distant future, the concept of "racing" another nation finally may fade into obscurity except perhaps in the arena of economic competitiveness as countries try to turn space into a profit-making enterprise. The question of "who's ahead" then may be easier to answer, since the measure will be dollars and cents, or rubles and kopeks (or francs, or deutschemarks, or yen)!

While U.S. space policy clearly should not be made in ignorance of what others are doing, it can be argued that policy should not be made simply in reaction to what other countries are doing either. Only after deciding what the United States, as a Nation, wants to do in space and is willing to spend to do it, can a rational decision be made on where to compete and where to cooperate with others.

Thank you very much for this opportunity to testify today. I will be happy to answer any questions you have.

FIGURE 1

COUNTRIES/ORGANIZATIONS WITH INDEPENDENT LAUNCH CAPABILITIES

COUNTRY/ORGANIZATION	LAUNCH RECORD THROUGH DEC. 31, 1988
CHINA	23 successes, 2? failures
EUROPEAN SPACE AGENCY	23 successes, 4 failures
INDIA	3 successes, 3 failures
ISRAEL	1 success, 0 failures
JAPAN	36 successes, 6 failures
U.S.	887 successes, 111 failures
U.S.S.R.	2,106 successes, ? failures

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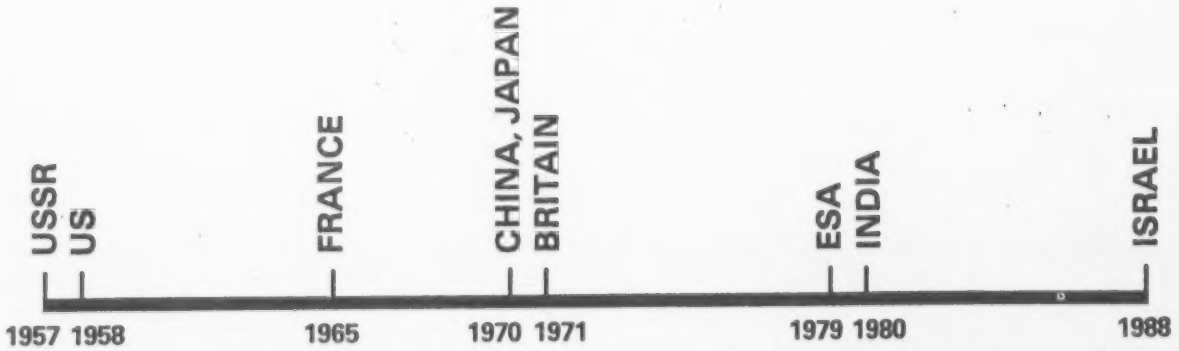
FIGURE 2

TIME-LINE OF FIRST SUCCESSFUL SPACE LAUNCHES



*Does not include Australia or Italy since they used U.S. rockets rather than developing their own. Britain and France no longer operate their own launch vehicles, but rather are participants in ESA's Ariane Program.

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FIGURE 3

NUMBER OF INDIVIDUALS WHO HAVE FLOWN IN SPACE

U.S.	126
U.S.S.R.	67
AFGHANISTAN	1
BULGARIA	2
CANADA	1
CUBA	1
CZECHOSLOVAKIA	1
FRANCE	2
GERMAN DEMOCRATIC REPUBLIC	1
GERMANY, FEDERAL REPUBLIC OF	3
HUNGARY	1
INDIA	1
MEXICO	1
MONGOLIA	1
NETHERLANDS	1
POLAND	1
ROMANIA	1
SAUDI ARABIA	1
SYRIA	1
VIETNAM	1
TOTAL INDIVIDUALS IN SPACE	**215**

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Figure 4

TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS

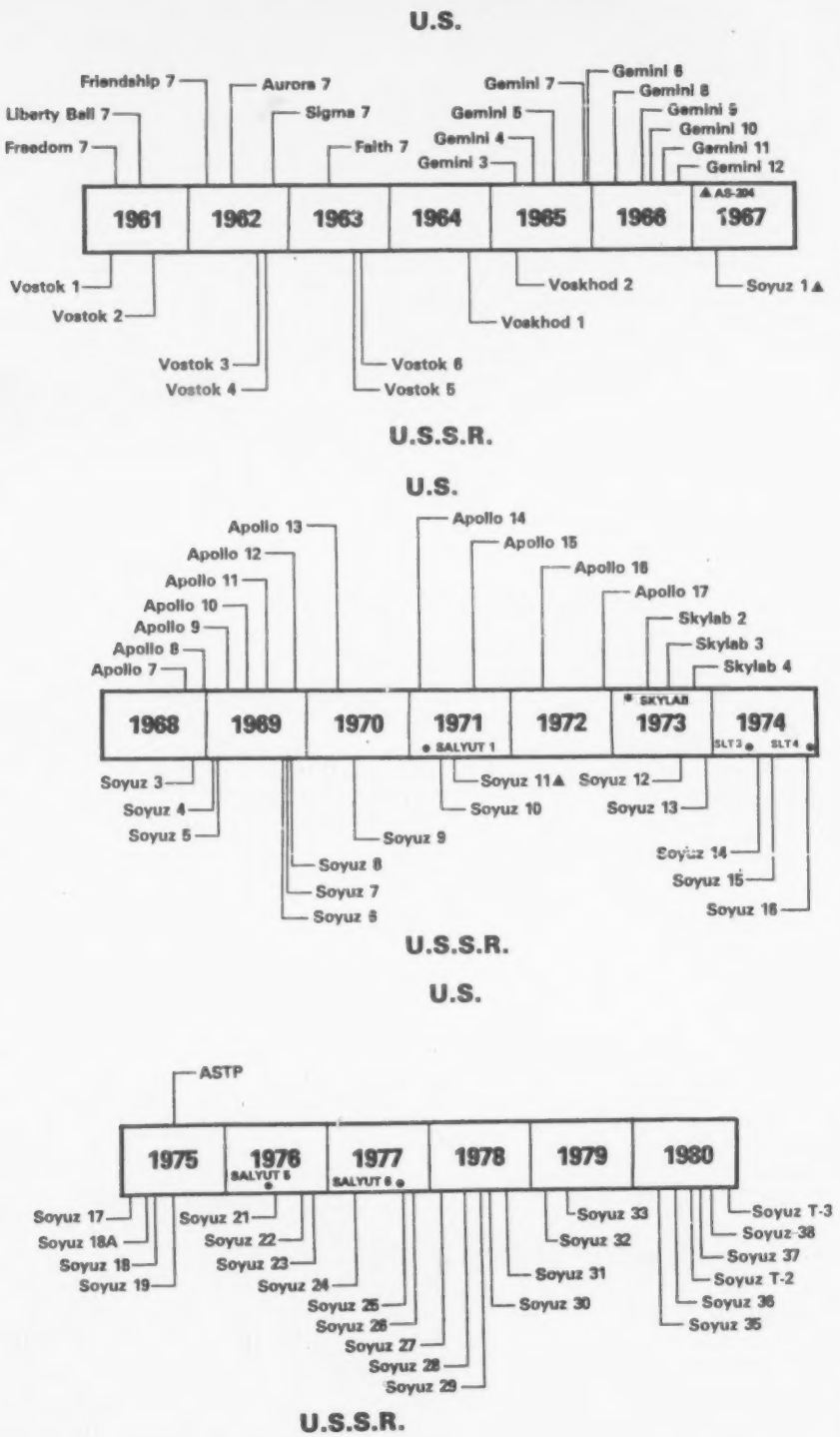
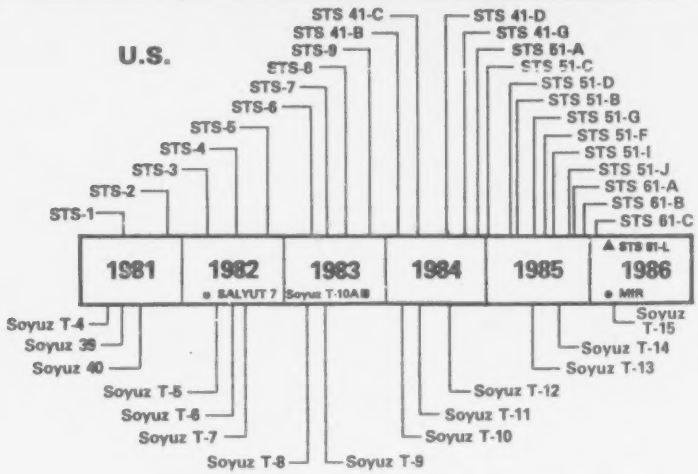


Figure 4 (cont.)

TIME LINE OF U.S. AND U.S.S.R. PILOTED SPACE MISSIONS (continued)



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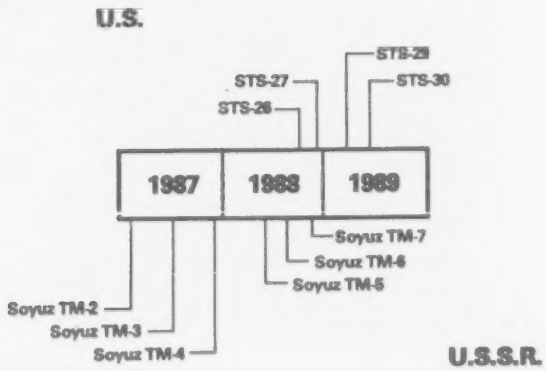

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Senator GORE. Thank you very much. One excellent and concise statement.

I was working up a little chart here. Call it a score card, if you will. I hate to do that because it does, perhaps, focus a little too much on the race aspect of the space program. But, just as a further effort to pin down where we are, where others are, and where we are going, I would like to ask you some questions based on this chart. I should have a large version, but basically it has a list of several activities on the left-hand side: manned space activities, space transportation, space science, space research and technology, space applications.

And then three columns: the current leader in each of these categories, the major challenger in each of these categories, and up and coming in each of these categories. And the candidates are the United States, the Soviet Union, the European Space Agency, Japan, China, India and Canada.

If you wish to add some nation, please feel free to do so.

In the first category, manned space activities, we will take your answer, Ms. Smith, as the answer for current leader. It is the United States in technological prowess associated with manned space activities, but the Soviet Union, in terms of cumulative experience in manned space activities.

Do either of the other two witnesses disagree with her answer there?

Mr. PEDERSEN. Not at all.

Senator GORE. Major challenger. I suppose there is not a major challenger there, is there?

Ms. SMITH. I do not think there is in either category. The United States, if it wants to compete with the Soviet Union in this area of cumulative hours in space, the only way we can do it is to build a space station. But presuming that the Soviets do not cancel their space station program, they essentially have a permanent presence capability already. And so if we get one, we still will not be able to catch up in the statistic, although the statistic will become less relevant as we do develop our own experience.

Senator GORE. Up and coming. What other nations on the list I mentioned would you expect to be involved in manned space activities in the foreseeable future, Mr. Pedersen?

Mr. PEDERSEN. As I said in my statement, certainly Europe, Japan and Canada are all going to be engaged in one form or another through their participation in the Space Station Freedom. All three of them are building hardware and components of the station. All three of them have astronaut programs in place, and they are training astronauts to participate.

In the case of Europe, you might add to that also the fact they are building a man-tended free flyer that will fly in formation with the station, but not be attached. They are also building a reusable manned space plane, the Hermes. Neither Canada nor Japan, at the moment, have such a plane under development. So I would say that Europe is at top of the up-and-coming category, with certainly Canada and Japan also involved.

Senator GORE. Space transportation. Who is the current leader?

Ms. SMITH. I would say that no country is ahead in space transportation. Countries develop the space transportation capabilities

that they need for whatever space program they plan. So you cannot say that one country is ahead because they have a more diverse or robust fleet. Because countries have made policy choices about what kind of launch vehicles they need.

The Soviet Union does have a diverse and robust fleet. The United States is now building the mixed-fleet capability.

One area that a lot of people look at is how many pounds into orbit a country can launch. And many people therefore say that the Soviet Union is ahead because they do have the Energiya launch vehicle, and we no longer have a heavy-lift capability.

But one thing you have to remember is what are the payloads that are going to go up on that launch vehicle. And the Soviets have not made clear what it is they want the Energiya for.

Senator GORE. Yes, but this is the narrow category: space transportation.

Ms. SMITH. If you want to talk about the technology of space transportation, I would say that we are about even these days. In terms of lift capacity into low-Earth orbit, the Soviet Union is ahead.

Senator GORE. Anybody want to amend that or change it in any way?

Mr. PEDERSEN. No, unless you add a separate category to that and talk about manned space transportation, in which case I would argue the U.S. is ahead in that category.

Senator GORE. Based upon the experience with the Shuttle?

Mr. PEDERSEN. Yes. And its technological sophistication.

Senator GORE. Space science. Well, first of all, in space transportation, who is the up and coming nation or major challenger in space transportation? ESA?

Mr. PEDERSEN. How about arrived?

Senator GORE. Major challenger, already arrived, all right.

Mr. PEDERSEN. I think when you have 50 percent of the commercial launch market, which has to be viewed as an important aspect of access to space, you have arrived. You have passed beyond up and coming.

Senator GORE. So ESA is the major challenger for the lead in space transportation. Anybody else in that category? What about up and coming?

Mr. MICHAUD. I think you have to mention Japan, Mr. Chairman. They are developing an independent launch capability, much along the lines of the one the Europeans have pursued.

Senator GORE. Space Science. Who is the current leader?

Mr. PEDERSEN. I think the U.S., beyond question. The Soviets and other countries can only stand in wonder and awe at things like the Hubble space telescope. We have recently been reminded by the Phobos experience of some of the limitations of the Soviet system. The Soviets have never been to the outer planets, and we are in the process of celebrating our encounter with Neptune. It is good to remember that.

Senator GORE. August 24th, is it?

Mr. PEDERSEN. That is correct, August 24th.

Senator GORE. Boy, when the history of the space program is written, there is going to have to be a whole chapter on Voyager.

Mr. PEDERSEN. I could not agree more with you. With Ulysses, Galileo, Magellan, I think we are in the clear lead in that area.

Senator GORE. Up and coming, or major challenger, first, would be the Russians?

Ms. SMITH. I do not think so. They really have not done all that much in space science. And one of their more successful observatories in Earth orbit, Kvant, which is docked with their MIR space station, actually is filled with European experiments. I think Europe, if anyone, is the biggest challenger.

Senator GORE. ESA would be the major challenger in space science. Up and coming?

Ms. SMITH. ESA and individual European countries, not necessarily working through ESA.

Mr. PEDERSEN. If I could make a small point. It may be semantic, but I think it is important. When you talk about space science, using phrases like "challenger," which puts it in a very competitive context; it seems to me this is an area where cooperation is very much the key. To talk about challengers and competition in the science environment is a little different than when you are talking about it in some of the other areas.

Senator GORE. Yes, but usually there is a driver and hitchhiker.

Mr. PEDERSEN. Yes. And science missions do spin off important technology. I do not want to underplay that.

Senator GORE. Yes. I mean, the cooperation is not really possible unless somebody is driving the mission.

Space research and technology. The same answer as with space science or different?

Mr. MICHAUD. The U.S., I think we would all agree.

Ms. SMITH. Yes.

Mr. PEDERSEN. I would agree with that.

Senator GORE. The major challenger?

Ms. SMITH. Europe.

Mr. PEDERSEN. Probably ESA, Europe.

Senator GORE. Space applications?

Ms. SMITH. The U.S. ahead; Europe is the challenger.

Mr. MICHAUD. Yes.

Mr. PEDERSEN. But the gap is narrowing rapidly, depending upon which applications you are talking about. Europe is coming on very strong in that area.

Mr. MICHAUD. And Japan is moving up behind.

Senator GORE. Okay. Now, in three of these five categories you have Japan in the up-and-coming group. Do we have a clear understanding of how quickly Japan is moving and what their intentions are with regard to space?

Mr. MICHAUD. Mr. Chairman, the Japanese have been quite open about their plans for space. They run their space program in some ways like ours. It is open to public view. And they lay out their plans well in advance, so yes, we do have a pretty clear picture of where they are going.

Senator GORE. And where are they going?

Mr. MICHAUD. They intend to have a completely autonomous launch capability. They intend to have autonomous capabilities in application satellites, such as communications and direct-broadcast

and remote sensing. And in the long run, though not any time soon, they want to have their own manned space flight capability.

Senator GORE. What does the long run mean?

Mr. MICHAUD. I think after the year 2000, realistically.

Senator GORE. Are they taking steps now to achieve that capacity?

Mr. MICHAUD. Yes, they are, Mr. Chairman. They are in the initial stages of developing an orbiting space plane, called the Hope vehicle, which would be launched on their H-II launch vehicle.

Senator GORE. I have run over my time. Let me just ask one more question and then yield to Senator Robb. Well, let me yield to you now.

Senator ROBB. You took about three of the questions I was going to ask with your chart. So I would yield to Senator Rockefeller.

Senator GORE. Senator Rockefeller.

Senator ROCKEFELLER. With respect to the Japanese, that H-II launch vehicle, they are expecting to test by what, 1992?

Mr. PEDERSEN. 1993.

Mr. MICHAUD. They just delayed it by about a year, Senator.

Senator ROCKEFELLER. And you say it will not be effective until after the turn of the century?

Mr. MICHAUD. No, we were referring to manned space flight capability.

Senator ROCKEFELLER. Could they be doing what they are doing without us having done what we have done, Mr. Pedersen?

Mr. PEDERSEN. When you say could they be doing what they are doing, do you mean in general terms in space technology?

Senator ROCKEFELLER. Technology, in general terms, yes.

Mr. PEDERSEN. Certainly, they have benefited significantly from U.S. activities. Their earlier launch vehicles were all developed under license, essentially Delta-class technology, that was sold to them by U.S. industry under license, by government agreement. They have certainly benefited.

Senator ROCKEFELLER. That selling is interesting, is it not? In other words, they knew what they wanted and they came and asked for the technology and what, took positions in the company or simply bought the technology?

Mr. PEDERSEN. No, they licensed the technology under a government-to-government arrangement. But it also provided the U.S. with a great deal of insight and a certain measure of control over the pace and direction of their space program.

Senator ROCKEFELLER. Well, following that up, has there been any reverse flow of technology? Is there anything that—obviously, we can monitor what they have based upon what we sell them, and one can have one's views about that, but has there been any reverse technology?

Mr. PEDERSEN. Well, in the space area, until very recent years, Senator, U.S. technology has, for the most part, been so superior, there has not been a great deal of reverse flow. The technology edge has been on this side. I am talking about space-related technology. That is evening up very, very rapidly in the space area, just as it is across the board.

I would say it is now very much of a concern. I think in previous years it was less of a concern because we clearly felt we had the lead.

Senator ROCKEFELLER. It is my understanding that what they are doing is developing their satellite, and while they are doing that, they prohibit any sale of American satellites in Japan—well, let me finish, then you tell me how I am wrong—but that they are willing to allow certain subcontracting, but that satellites are not.

In fact, I assume there has to be something true in that because we have got a Super 301 on them with respect to satellites. Could you clear me up on that, and then explain to me why it is that my hunch might be wrong that they are trying to protect their satellites while they develop their launch vehicle. When they have developed their launch vehicle, and then have developed their satellite, then they will go around the world and do lots of interesting things in competition with us.

Mr. MICHAUD. Mr. Chairman, it is our perception that they are protecting their satellite industry. However, at the same time, American satellite manufacturers have been major players in the Japanese satellite market.

Senator ROCKEFELLER. On a subcontracting basis?

Mr. MICHAUD. They are, in effect, the real contractors for a high percentage of the material that goes into those satellites.

Senator ROCKEFELLER. Could you explain that to me, then: the difference between direct sales——

Mr. MICHAUD. In other words, as much as 80 to 90 percent of the satellite is American made in some cases. It varies from one satellite project to another. So, American companies are benefiting from sales to Japan in the satellite field. But the Japanese are trying to establish an independent satellite capability.

Ms. SMITH. And, Senator, if I could add, I do believe that the restrictions in Japan only apply to government-owned satellites. Private companies in Japan, and there are now two in the communications field, may buy their satellites from America if they wish.

Senator ROCKEFELLER. And what is the ratio as between the government's efforts and private efforts in Japan?

Ms. SMITH. It is hard to say right now, because the private companies are relatively new. I think they were established in 1985 or 1986. And until then they were all government-owned. But as to the future pace of the program, I honestly do not know the statistics on how many of the private companies plan to buy and how many the government plans to buy.

Senator ROCKEFELLER. So you would not characterize, then, the Japanese as trying to protect their satellite development?

Ms. SMITH. I would not disagree with Mr. Michaud's characterization of their attempts to do this. Whether or not they will be successful, I do not know. I was trying to point out that the government has a policy for government-owned satellites that does not apply to all Japanese satellites.

Senator ROCKEFELLER. Could you send to the Committee your understanding of the difference between—that is the ratio of government activity in that field, with respect to satellites, as compared to private activity, whether it is from 1985 or 1986?

Ms. SMITH. Yes, I would be happy to.

[The following information was subsequently received for the record:]

According to the Japan desk at the U.S. Department of Commerce, the Japanese government is planning seven new satellites in the next five years (for weather and other types of remote sensing, communications and broadcasting). The Department of Commerce official did not know if contracts already had been signed for manufacture of any or all of these satellites. Two satellites might be procured for private companies in Japan in addition to four that have already been ordered.

Senator ROCKEFELLER. Thank you.

Thank you, Mr. Chairman.

Senator GORE. Thank you.

Let me ask a few more questions before moving to our next panel, and before recognizing Senator Rockefeller again if he wishes.

Ms. Smith, you mentioned Skylab as the last mission before this long hiatus from 1973 until the first shuttle flight in 1981. A hiatus interrupted briefly by the Apollo-Soyuz mission if I am not mistaken, is that right?

Ms. SMITH. The hiatus was actually between Apollo-Soyuz, which was in 1975, and the first shuttle mission that was in 1981.

Senator GORE. Well, there were no missions in 1974, were there?

Ms. SMITH. Well, the final Skylab crew came down in 1974. They came down in February of 1974. It is true there were no new launches, but there was a crew up in space during 1974.

Senator GORE. Okay. And then from Apollo-Soyuz in 1975, the middle of 1975, until the first shuttle flight in 1981, we went for six years with no U.S. manned-space flight?

Ms. SMITH. That is correct.

Senator GORE. And during that time, the Soviet Union put up 20 manned space flights during the time when we were grounded.

Ms. SMITH. That is right. And almost all of them were to a space station.

Senator GORE. And then we had a another hiatus from the first part of 1986 until the latter part of 1988. I believe you said 32 months.

Ms. SMITH. That is right.

Senator GORE. And, of course, that was because of the Challenger tragedy. But, cumulatively then, we have had, since the beginning of the space race, those two periods, together make up about nine years during which we were on the ground and the Soviets were continuing to move forward in manned space flight.

Ms. SMITH. Yes. There was, of course, the earlier accidents which shut down the American program for 21 months after the Apollo fire.

Senator GORE. You could include that, too, yes.

Ms. SMITH. And the Soviets have had two periods where they have had no flights because of accidents, also at that same time after the Soyuz 1 tragedy when they did not fly for 18 months. And then in 1971 they had another fatality, a three-man crew that was killed, and they did not launch for 27 months.

Senator GORE. A much more complete view, and I thank you.

On Skylab, how much would it have cost to keep Skylab in orbit?

Ms. SMITH. I do not know how much it would have cost to keep it in orbit. Skylab really was not designed for permanent occupancy. I

suspect that if the Nation had wanted to go forward, they would have launched the back-up Skylab, rather than trying to keep that one space station up and operating.

Senator GORE. Yes. But if we had chosen to modify Skylab for other uses, I am told that at a cost of $100 million, we could have shifted it to another orbit. Mr. Pedersen, do you know anything about that?

Mr. PEDERSEN. I cannot give you the specific dollar figures. I do know that, as you perhaps recall, the initial plan was to have the shuttle available at a much earlier date than it did fly. And there was some talk about using the shuttle to go up and put Skylab into a higher orbit, and perhaps do some modifications on it. But with the Shuttle delays and the reentry of Skylab, that, of course, became academic.

Senator GORE. Now, you have said that the answer to the question "Who is ahead?" now has to be viewed in the context of commercial markets in the future. One of the most important of those markets is the market for commercial launch services.

I have spoken in the recent past and introduced legislative language dealing with my concerns about the Australian plan to launch American satellites on Soviet-built rockets. This plan, if it goes forward, could severely disrupt the international market for commercial launch services. At least that is my view.

We have pretended that there is a market that reflects supply and demand, sometimes without acknowledging the disruptive element of national subsidies—by the Chinese, for example—which make market signals almost irrelevant and drive would-be competitors out of the business altogether, leaving the potential for those nations subsidizing their launch services to capture and monopolize the market after the competitors, listening only to market signals, have left the market place.

Now, if the Australians go forward with this, you have a technology transfer problem with American satellites on Soviet rockets, and you also have the disruption of the commercial market place. I am wondering whether or not you share the concerns I have just expressed, or if you would like to put them in any different way?

Mr. MICHAUD. Mr. Chairman, may I respond initially. First, a bit of background. As I believe you know, in 1987, there was a proposal that we allow U.S. satellites to fly on Soviet launch vehicles. The Secretary of State at that time communicated to the Chairman of General Motors that it was our policy that we would not approve the export of U.S. satellites to the Soviet Union for launch into space.

Since then, this proposal for a spacecraft at Cape York in Australia has emerged. We have communicated to the government of Australia two points. The first is that we are neither for nor against Cape York as a space port. We take no position on it. It is a commercial enterprise sponsored by Australians.

However, we have told them that we do have serious reservations about the idea of using Soviet launch vehicles to launch Western satellites, and that we might, indeed, have technology transfer concerns and policy concerns about that going forward. And that is the state of the discussion today.

Senator GORE. Does anyone else wish to respond? Mr. Pedersen.

Mr. PEDERSEN. I cannot add to what Michael has said in his response. I think when you look at the distinction between the Long March decision and the Soviet proposal to launch everything from satellites to the Space Station for us, the difference really comes down in the end to technology transfer judgments and policy considerations.

I will say, though, that in the case of the Long March decision, which was, as I said in my testimony, to allow certain U.S.-built satellites to be launched on Long March Vehicles, you find that the situation is extremely complicated. You can make a decision, for example, designed to benefit the U.S. commercial launch vehicle industry by prohibiting American satellites from going on other launch vehicles.

But in the process of making that decision you could do great damage to the U.S. telecommunications satellite industry, which is a very profitable industry. Because foreign customers, if they believe that by buying a U.S. satellite they will then be deprived of their rights to choose a space transportation company, might well decide instead of using U.S. transportation, to simply buy their satellites somewhere else.

So these are very complicated judgments.

I think in the case of the Soviet Union, however, we have very special considerations. And I share the view that we ought to be extremely cautious about even considering putting U.S. satellites on Soviet launch vehicles.

Senator GORE. Ms. Smith.

Ms. SMITH. I have nothing to add, Senator.

Senator GORE. All right. I added an amendment to the fiscal year 1990 NASA authorization bill that indicates U.S. policy in this area should be extended to prohibit the launch of U.S.-made satellites on Soviet launch vehicles in nations other than the Soviet Union. And I was interested in your views of this matter. But we do have another panel and I also want to recognize Senator Rockefeller for a second round.

Senator ROCKEFELLER. I have nothing, Mr. Chairman.

Senator GORE. Very good. Let me thank you, all three, for appearing here. Thank you very much.

Let me ask our second panel to come forward.

And we may be interrupted just as the second panel is beginning because of a vote at 3:15. But let me invite the panel to come on up. And I will introduce you. And then we will adjourn for the vote and come back for the panel.

First of all, Mr. Aaron Beck, could you raise your hand? Aaron Beck from Spring Hill Elementary School in McLean, Virginia; Miss Ashley Duncan, welcome, from the Kino Learning Center, Tucson, Arizona; Damon Butler, from Oxon Hill High School in Oxon Hill, Maryland, welcome; Josh Adams—is Josh with us?

Come on up and have a seat. Josh Adams is from Montgomery Blair High School in Silver Spring, Maryland; Jennifer Stolbach, come on up and have a seat. Jennifer, from the Watkins Mill High School in Gaithersburg, Maryland; Terrence Taylor, from Brown University, Providence, Rhode Island; and James Ruffin, from the University of Maryland in Baltimore.

Well, welcome to all of you. What we will do is ask each of you to say a few words about this subject that we are discussing. Some of you have typed out statements, and we will include those in the record in full. If you wish to read, that is fine; if you wish to summarize, that is fine.

But I want to say again that during this panel, we may well have a bell ring indicating a vote on the floor, at which time we will have to have an interruption in the hearing and we will adjourn for a little while and then come back.

Let us start with Aaron Beck from the Spring Hill Elementary or is it Cooper Intermediate, which one is it?

STATEMENT OF AARON BECK, SPRING HILL ELEMENTARY SCHOOL, McLEAN, VA

Mr. BECK. I am going to Cooper this fall.

Senator GORE. All right. Very good. Cooper Intermediate School. Welcome. Please tell us what is on your mind about America's space program.

Mr. BECK. Mr. Chairman and members of the Subcommittee, my name is Aaron Beck. I am 12 years of age. I have just completed the sixth grade at Spring Hill Elementary in McLean, Virginia and will be attending Cooper Intermediate in McLean as a seventh grader.

I have been asked to speak to this committee about the national space program, how it has influenced my school work and what I think the goals of the program should be in the future.

The first thing I would like to talk about is how the space program has helped me with my education.

This year the sixth grade students at Spring Hill participated in the Name the Orbiter contest. Our name, "Godspeed," was chosen to be Virginia's entry. It was a lot of hard work, but a lot of fun, too.

I also have been a member of the Young Astronauts Program at Spring Hill for one year. The club met once a week for two and a half hours. In the club there were 32 people. Mr. August Frattali and Mr. Richard Tritle were our chapter leaders.

I did many things in the Young Astronauts Program. The things that I liked the most were building and launching rockets, and the science experiments we did. To do these things correctly I had to use science, math and reading.

As part of our Chapter's activities we took several field trips. When the rocket club went on a field trip to Goddard Space Flight Center we got to see a mock-up of a satellite. I thought that the satellite would be a lot bigger. We also took a field trip to the space convention at the Hyatt Regency and learned how the new space station will work. I did not know that different countries are helping in building the space station.

During the year we had various speakers come and talk to our club. Some of the speakers were Philip Culbertson, astronaut Ed Gibson, and even Dr. Fletcher, former director of NASA. These people talked about space vehicles, space stations, living conditions in space, and using satellites to get information about the Earth.

At the end of each year our club has an open house to show other people what we have learned all year. Each student had a topic that were assigned to research. In a booth you had to show all the things you learned during the year about your area. The area that I was assigned to was propulsion. I made a CO2 car that I demonstrated, showed a videotape on Pegasus and gave out written material.

The Young Astronauts Program has helped me in many different ways. It has helped me expand in science because a lot of the things that we covered in the program I would not have learned in a regular science class. It also helped me in writing because I have started to write business letters to different companies like Boeing, Sanger, and Pegasus, asking for various things.

Now I appreciate space much more and I know more about the NASA program and how it works. I am also beginning to see a connection between the importance of the space program and its role in our lives on Earth.

In the future, I would like to see the NASA program try to explore other planets more. The reason we should explore other planets is to see if it is possible to live on them. I also think we should try to build more shuttles or other space vehicles so we will be able to take more trips to space and learn more about other planets and stars.

I think that the government should put more money into the NASA program and into the Young Astronauts Program because we need to learn more about space and its possibilities for furthering our understanding of the universe.

This concludes my testimony. I would like to submit it for the Congressional Record along with a small packet from my teacher, Mr. Frattali.

Senator GORE. Very good. That was a terrific statement, a good way to start the panel. We will have some questions, but we will wait until everybody has made their statement.

And the next one will come from Ashley Duncan, with the Kino Learning Center in Tucson, Arizona.

Welcome, Ashley.

STATEMENT OF ASHLEY DUNCAN, KINO LEARNING CENTER, TUCSON, AZ

Miss DUNCAN. Thank you.

Mr. Chairman and members of the Senate Committee, my name is Ashley Duncan and I am 15 years old and a student at Kino Learning Center in Tucson, Arizona.

I have been an active member in the Young Astronaut Council since it was established in my school in 1986. The three of us here today represent over 500,000 students between the ages of six and 16, in 50 states and 37 other countries.

The Young Astronaut Council was established in 1985 to promote interest in science technology and mathematics among students in elementary and junior high school. The teachers at Kino Learning Center have played an important role in the Young Astronaut Program. The Kino teachers research, write and illustrate the core curriculum used by the Young Astronaut chapters across the

United States. The Kino students test the learning activities before they are included in the monthly packets.

I would like to enter into public record by reference a copy of the Young Astronaut Council curriculum for the 1988 and 1989 school year.

Each Young Astronaut chapter is encouraged to develop its own activities related to aerospace. Our chapter at Kino Learning Center has constructed a full-size model of the shuttle orbiter, flight deck and middeck. We have named our shuttle the Explorer. We use our simulator for one- to five-day shuttle flights. I have been on 37 shuttle flights and have logged over 1,000 hours in space.

Our student crews perform jobs similar to NASA astronauts.

Senator GORE. We ought to take that into account when we measure the U.S. and Russian experience.

Go ahead.

Miss DUNCAN. We conduct numerous experiments and record the results in journal logs. We exercise, eat and sleep in the orbiter's middeck.

We were very excited to have the STS-26 mission start. At that time, we had a special five-day mission that monitored all communications between NASA shuttle and mission control by satellite dish.

The most important lesson we learned through our overnight shuttle flights is the necessity for teamwork. The NASA shuttle and the Kino shuttle cannot fly without the cooperation of the crew. When the crew shuts the door of the Explorer, they soon discover that they are the only ones who can make their flight a success or a failure. Over time, the students' sense of responsibility grows. And they come to understand that they are the only ones responsible for creating not only a better shuttle flight, but a better school, and a better Tucson, and a better world.

The shuttle Explorer is located at Kino Learning Center, but it is used by students throughout Tucson, Phoenix and all of Arizona. It is used on school days, weekends and throughout the summer. We have had over 120 shuttle flights and have logged over 5,068 hours in space, with over 500 children participating throughout Arizona and the southwestern United States.

Mr. Chairman, Kino's participation in the Young Astronaut Council has been the single most important factor that has contributed to the success of our aerospace program. I would now like to address what I believe are the strengths and needs of this program.

First, the Young Astronaut Council provides thousands of teachers and hundreds of thousands of students with the opportunity to learn about the United States space program in ways that are active, enjoyable and memorable. It provides us with hands-on activities where we can learn about America's space program. And it encourages us to plan out for what space might become.

For instance, in the commemorative lunar landing packet, we asked adults to recall their memories of the Apollo 11 landing. We learned about new concepts of mass drives and gravity wells. The Young Astronaut Program lets us mix the facts of the past with our plans for the future.

Mr. Chairman, I believe the Young Astronaut Council bridges the gap between cultures and countries. Two years ago, I had the opportunity to represent the United States at a Young Astronaut conference held in China. I stood in Tiananmem Square and talked with teenagers from Beijing. We shared our hopes and dreams for world peace. Today, I share their pain more deeply because they shared themselves so fully.

The same summer I joined Young Astronauts from all over the world in Tokyo, Japan for an international conference. The highlight of the trip was staying with a Japanese family and sharing in their customs and cultures. At that time I thought it was a once in a lifetime opportunity. But this week, I will be returning to Japan for my second Young Astronaut International Conference. The Young Astronaut Council has made the other side of the Earth more real for me.

Another strength of the Young Astronaut Program lies in the encouragement to have people grow with it. Each Young Astronaut chapter has its own unique strengths that reflect the use of local resources. At Kino Learning Center, we participate in the Wright Flight Program. After studying the history of aviation, we flew with pilots that actually let us take full control of the planes. The purpose of this program was to show discouraged students that learning can have immediate rewards. We also visited and learned a great deal about Flandrau Planetarium, Stewart's Observatory, Kitt Peak Observatory and Biosphere II. Biosphere II moves us well into our future.

Mr. Chairman, I would now like to talk about what I believe is the future for the Young Astronaut Program.

At the present time, the Young Astronaut Program provides learning activities for children between the ages of six and 16.

Senator GORE. Let me interrupt you briefly to say that because this is my amendment on the floor, I am going to have to go over. And Senator Rockefeller is going to continue the hearing. And then at an appropriate break point, he will adjourn it and we will come back and start again.

So, please continue.

Miss DUNCAN. I have a special interest in making the Young Astronaut Program available for children in early childhood programs across the United States. At Kino, a friend and I planned and conducted a 24-hour shuttle flight for students between the ages of 3 and 6 years old. After a week's preparation we were ready to go. We went up and came down safely. The flight was a great success for everyone.

For some children it was their first night away from home. And I heard one boy say, "I cannot believe my mom let me go into space without her."

Mr. Chairman, I think it is very important to get children interested in space at a very early age. The attitudes they develop will last a lifetime.

I also think the Young Astronaut Council needs to develop its program more fully for high school students. I think astronomy and aerospace should be a high school course, just like biology, chemistry and physics.

I would also like to see the Young Astronaut Program established in more schools, particularly inner-city schools. I think it is important that more children be given the opportunities to develop the confidence that I have developed through this program.

Finally, Mr. Chairman, I would like to state some concerns and hopes for a national space program. I believe my views are shared by many children and teenagers in the country and around the world. On their behalf, I ask that Congress commit to the respectful and peaceful exploration of space. It is important that we use our increased knowledge of Earth to take better care of it. And it is essential that human actions that have threatened the balance of Earth not be transported beyond our planet.

Space exploration is an important part of our high-tech society. It is of the utmost importance that high technology lead to an increased quality of life for everyone and everything on planet Earth.

Mr. Chairman, I represent the children of Earth when I request that you and all members of Congress make decisions that lead to a peaceful exploration of space. The children of this planet will inherit the consequences of your choice. It our right to inherit a peaceful planet. It is our duty to pass this fragile gift on to our children when we are in positions of national and global leadership.

The goal of the Young Astronaut Program, then, is nothing less than world cooperation, peace and progress. May this goal become the intent of every member on planet Earth.

Mr. Chairman and committee members, it has been a privilege to address you today on behalf of children everywhere. I thank you for this opportunity and I wish you peace, peace through space.

Senator ROCKEFELLER [presiding]. Thank you very much, Miss Duncan. It is now the half-way point in the vote, and I also have to go vote. And so we will take a recess of about ten minutes. And then at that point Senator Gore will be back here.

[Recess.]

Senator GORE [presiding]. The subcommittee will come back to order. I am sorry for the delay.

You might be interested that due to a temporary lapse in judgment, the Gore amendment was not successful on the Senate floor, a marginal mistake on the part of the Senate. But in any event, let us proceed now, and I believe that we have completed your statement, Ashley, and we are just up to the statement of Damon Butler from Oxon Hill High School.

STATEMENT OF DAMON BUTLER, OXON HILL HIGH SCHOOL, OXON HILL, MD

Mr. BUTLER. Mr. Chairman, members of Congress and distinguished guests, it is a distinct honor and great privilege to talk with you about America's future in space and the Young Astronaut Program. I am delighted that the Congress of the United States has shown interest in the program and cares enough to listen to the youth of America, the youth that will hopefully continue the progress and success of the space program throughout the twenty-first century.

First, I would like to tell you a little about myself. My name is Damon Butler, and I am a 15-year-old sophomore at Oxon Hill High School, where I am presently enrolled in the science and technology program. This is a program designed for students with special interests in math, science, and engineering.

I am also involved with the junior ROTC. Prior to enrolling at Oxon Hill I received numerous awards and certificates. Among the more notable are certificate of recognition for outstanding achievement in math, certificate for the summer enrichment program for talented and gifted students held at American University, completion of a summer course in computer literacy, high Stanford and California Achievement test scores and continued Honor Roll status since being enrolled in school.

Now, I would like to tell you about the Young Astronaut Program, its influence on me, and finally the goals and objectives I hope the program can achieve.

I have been a member of this group since its organizational inception in 1984. The Young Astronaut program allows us to follow a dream, not just one person's dream, but the dream of a nation. Everyone at one time or another has looked up into the vast sky and wondered what is up there. What would it be like living there. Is it possible to live beyond the heavens.

Mr. Chairman, the American space program is the envy of the world. I have traveled to Mexico on an exchange program and have met with other children in Huntsville, Alabama, during a one-week session at space camp. We all agreed that the American space program provides excitement for children, including the very young.

The Young Astronaut program keeps you up to date with the latest developments in space technology through monthly newsletters and curriculum materials. In these newsletters there are pictures, stickers and stories of what other children have done in the aerospace field. In other words, this program allows children to actively participate in, contribute to, and profit from the technological advances in the aerospace field.

In my life I have been influenced by many things. For example, my parents, family, friends, school, and the aerospace field. My parents have given me morals, my family, love, my friends, support, my school, knowledge, and the aerospace field, hope.

The aerospace field broadens the horizons of a nation with the sincere feeling that anything is possible. It also gives the nation hope of a better tomorrow. It is like thinking about heaven. You know it is going to be beautiful, but you will not know how beautiful it will be until you get there. Though there are many uses for space, my colleagues and I agree that most importantly space must be used to create jobs, ensure our security, and to provide peace for the world.

Just recently I read an article about private and public entities in Long Beach, California that have joined forces to create jobs in the aerospace field. Chemical weapons have brought fear into the hearts of many people, but with the advancement of space technology, these weapons can be shot right out of the sky without harming anyone.

Space has also a good place to make medicine because of the different environment. Space could be the place where we find the

cure to the AIDS virus. There are so many things that we can do in space that we should not just limit ourselves to the obvious.

Mr. Chairman, I am the beneficiary of a family that has made many educational opportunities like the Young Astronaut Program available to me, and I look forward to a future career in aerospace, but I have three major concerns. First, will the U.S. government have the foresight to ensure that there are funds available to continue America's exploration of the planets and the building of the space station where I hope to live and work someday. Second, will the U.S. commit itself to educating its young people. Third, will our generation be prepared to assume those technological roles, challenging the youth of America to take the lead roles in building an even stronger space program is the first step.

Mr. Chairman, I urge you to take whatever steps are necessary to assure that all Americans, especially blacks, Hispanics and other minorities are being prepared for life in the twenty-first century. Black astronauts like Colonel Fred Gregory, who grew up in the shadow of the Capitol, serve as great role models for us. As we travel into the space age, we must take all Americans with us. We must make aerospace opportunities available for everyone.

On a personal note, my grandfather has seen this nation's aviation and space program go from Kitty Hawk to the space shuttle to the space station. Even as we speak, the unmanned satellite Voyager II launched a decade ago is headed for an encounter with the planet Neptune. All of this has happened in one man's lifetime. Just think of the possibilities for my colleagues and me in our lifetimes.

We can only begin to imagine the many uses for space. Someday space shuttles will be making more flights than airplanes. People will even be taking vacations to Mars and Neptune. I just hope that my generation is around to see it. We have every reason to believe that not only will we follow in the footsteps of those brave Apollo astronauts who first stepped on the moon, but that we can go to Mars and beyond. All we ask is that the policymakers of this nation provide us with the opportunity to fulfill our dreams.

The greatest technological undertaking in history culminated in 1969 with the first landing of men on the moon. Although the lunar landing mission happened before I was born, I have followed with great interest its impact on America. There seemed to have been great vision by President Kennedy, excitement among all Americans, and a commitment by the nation to make the within a decade dream come true.

I believe that now is the time on the anniversary of Apollo to announce another commitment to return to the moon or to go to Mars. Why wait? The time is now. It is only fitting that on the 20th anniversary of the first landing of men on the moon by the Apollo XI lunar landing mission that the Congress of the United States be mindful of the Young Astronaut Program and the fact that the youth of America has to continue the space program with the same vision, drive, and commitment that has been shown by NASA throughout the twentieth century. Man has dominion over earth, ocean and air, and soon we will also have dominion over space.

In conclusion, I would like to say that the continued success of the space program depends on the youth of America and their knowledge of space. Concepts like the Young Astronaut program will be the cornerstone for an even stronger space program and the building blocks for generations to come.

As we leave here today, our fate and the fate of a nation is in your hands. I know you will not let us down. With God's help, the support of Congress and the determination of its people, the space program will soar full throttle ahead. Thank you.

Senator GORE. That was really an excellent statement, and all of the statements have been excellent, and I look forward to the others.

Let me just say at this point that I am going to personally guarantee that we collect and print and distribute these statements being made to the United States Senate here today by these young people to every members of Congress, and make them available to the American public. I really am impressed with these statements.

Now, the next person on my list is Josh Adams. Josh, please proceed.

STATEMENT OF JOSH ADAMS, MONTGOMERY BLAIR HIGH SCHOOL, SILVER SPRING, MD

Mr. ADAMS. Thank you. My name is Josh Adams. I live in Montgomery County, Maryland, where I attend the Math, Science, Computer Science Magnet Program at Montgomery Blair High School. This past year I wrote a proposal for an experiment on the space station. It was a combination of an entry into the space science student involvement program, a competition sponsored by the National Science Teacher Association in NASA and a project for the class called Research Experimentation.

My proposal was to determine the effects of microgravity on cocoon production by silkworms. I was one of the 40 semifinalists in the national. Half of us went to Cleveland, Ohio, where we stayed at a hotel near the Lewis Research Center. We visited Lewis several times during the five-day stay and talked to scientists from Lewis and other research labs in the area. They told us how to improve our proposals for reentry into the national level.

I am interested in studying science and computer. The Magnet emphasizes and encourages the study of science and math. I feel we need other such scientifically oriented schools in the country so future researchers and engineers can develop new ways to explore space and uncover its mysteries.

I may decide to be an astronaut and with the specialized education from the Magnet, I have a better chance of succeeding. Other students should have similar opportunities.

I think it is important for man to explore space. There are many reasons, for instance, finding new life or new energy sources. I also feel that the space station Freedom is a very good idea. The scientists on it are able to conduct experiments continuously without having to return to earth periodically to supply ships mostly unmanned and save time and expense.

The journey to other planets or even solar systems at this stage of our technology should be unmanned. That way NASA will not

have the expense of supporting man for very long periods of time in space. Manned flights would not gather much more information than unmanned, so it is not necessary. Later, if needed, manned flights can be used. And I think that the space program should be continued as long as possible and everything should be done to continue it. Thank you.

Senator GORE. Thank you very much. A very fine statement.

Jennifer Stolbach, welcome.

STATEMENT OF JENNIFER STOLBACH, WATKINS MILL HIGH SCHOOL, GAITHERSBURG, MD

Ms. STOLBACH. My name is Jennifer Stolbach. I will be a junior at Watkins Mill High School this coming fall. During my freshman year at Montgomery Village Junior High School I participated in a science program called Research and Experimentation. We learned by doing.

That year one of our assignments was to create an experiment that would be recreated in a space environment, a space station. This, of course, was the Space Science Student Involvement Program, SSIP, offered by the National Aeronautics and Space Administration, NASA, and the National Science Teachers Association, NSTA.

The title of my experiment was to produce penicillin in two different atmospheres and to compare the results of their interaction with bacteria. The problem is to determine if the penicillin produced in the space station would be more effective in killing the streptococcus bacteria because of coming from a zero gravity atmosphere to a one gravity atmosphere.

I had hypothesized that the penicillin created in the space station would be more effective in killing the streptococcus bacteria because of the lack of gravitational pull. The cell development would be more rapid.

The abstract of my experiment is as follows. My experiment would evaluate a method of producing a strengthened penicillin. Staphylococcus aureus, a bacteria, is contaminated by Penicillium notatam using a hypodermic needle with a syringe in a one gravity earth atmosphere and a zero gravity space atmosphere. On earth the results will be introduced into streptococcus and evaluated using microscopic analysis.

I proposed that the experiment be performed in eight Petri dishes, four on earth and four in the space station. My experiment placed second regionally, which includes our 11 states.

I really enjoyed working on this project which led me to believe that my career goals should lie somewhere in the science field. I found that I would be interested in many different areas including psychology or psychiatry because of my interest in people and the way they function. I also enjoy creating and researching experiments which could lead to a researcher in the sciences. My greatest interest lies in sports medicine, because I would really like to combine my two greatest interest, athletics and the sciences.

I am very impressed by the space program. The fact that it was on 20 years ago that we stepped onto the moon bewilders me. We have come so far in so little time. I am very happy that NASA and

the NSTA have given students a chance to participate in the space program. This allows us to step into the future and participate in the making of history. Thank you.

Senator GORE. Thank you very much for a very fine statement again.

Our next presenter is Terrence Taylor from Brown University. Welcome.

STATEMENT OF TERRENCE TAYLOR, BROWN UNIVERSITY, PROVIDENCE, RI

Mr. TAYLOR. Thank you, Mr. Chairman. Good afternoon, Mr. Chairman and members or absentee members of the subcommittee and distinguished guests and general audience.

Senator GORE. Let me interject at that point to say that when we have legislation being considered on the floor, the Senate, it is very common for members to be there on the floor of the Senate, and we did not know when this was scheduled that we would have such active consideration of a bill, but it is also very common for members and their staffs to follow the record of these proceedings very closely and for the printed record to have tremendous impact on people who study what is said at these hearings. And so, please do not be misled or feel badly by the fact that some of these Senators who were here earlier could not be here throughout the proceeding. That is fairly common in the Senate, but this gentleman right here is making a very careful record of everything that is said, and we are going to distribute it far and wide, so please proceed.

Mr. TAYLOR. Thank you, Mr. Chairman.

First, I would like to introduce myself. My name is Terrence Taylor. I will be matriculating at Brown University in the fall. I am a graduate of Albert Einstein Senior High School in Kensington, Maryland, and I am a third year SHARP participant. My main task during my speech will be to speak to you generally about the SHARP program itself, and before I do that, I would first like to give you my thoughts on the space program in general which will include my thoughts on the space program before SHARP and after SHARP and then the final part of my speech will be my involvement in the SHARP program.

My thoughts on the space program in general before SHARP was that I wanted to be an astronaut because ever since I was a young lad, I guess I can say, I always stared up at the sky and wondered about the stars up there and wondered what was it was like to be in space, and I always thought I wanted to me an astronaut, but to me before SHARP being an astronaut only included piloting the space shuttle. I knew no better.

After the SHARP program, after my first year in the SHARP program, I got an insight into exactly what the space program was, and I finally realized that being an astronaut was more than just piloting the space shuttle. It involved a lot of mission specialists and a lot of people working very hard to make sure that the shuttle flies right, for one, and when the experiments are carried out in space that these experiments work.

Now, I will briefly speak to you about my involvement in the SHARP program, but before I do that, I would like to explain to

you exactly what the SHARP program is, what it entails, and what it does and what it means.

The SHARP program is the acronym which stands for Summer High School Apprenticeship Research Program. In the program we basically get an opportunity, a tremendous opportunity to learn while being paid. No other program that I know of gives the students from high school—generally students become eligible for the SHARP after their sophomore year. It gives us—a high school junior, let us say, for the next year a chance to learn about science and technology and mathematics related fields while being paid, and we also gain, like I said, gain an insight into the science and math-related career fields.

My first year in the program I basically worked on—with a mentor because each student is paired with a mentor that he or she meets on the first day of the orientation into SHARP and then he or she stays with that mentor for the eight or nine weeks of the program runs, and that mentor is like the student's direct boss, and then the next boss for the student is the supervisor, and she is present today, and I would like to recognize her today, Ms. Gosier.

What our mentor would basically have to develop a program that is viable and tangible for both the student and mentor which benefits the student and definitely benefits the mentor, and also we have to write research papers generally speaking about or generally covering—let me say covering the field which we researched during our apprenticeship at Goddard, and then we have posters which we make for our VIP nights presentation, which I always find a little bit fun because we have a lot of parents and dignitaries who are at the VIP night celebration, and basically these people have never seen or heard about some of the projects that we are working on, and we the students are charged with the task of explaining our projects and our whole eight weeks, all the work we have done during the eight weeks to these people, our parents, and the dignitaries in such a manner that they understand it, and it is always a great sense of accomplishment when you can explain your project in such a manner that somebody nods their head in approval saying, oh, I see—I mean, since being that that person had never heard about it before. So, in a way, one of the benefits of SHARP is it teaches you great salesmanship because you have to like sell your project and what you have done in the nine weeks.

And, once again, what SHARP does is basically it instills confidence, confidence—well, let me say for myself, I gained a lot of confidence from the SHARP program when the time came to apply to colleges. Before the SHARP program, I would have never even dreamed of applying to a university such as Brown or any other Ivy League school for that matter. But after my first year of participation in the SHARP program as a junior, in February of my junior year I started receiving mail, let me say letters from different colleges, and one of the first colleges that wrote me was MIT.

Now, everybody knows the reputation MIT has, and here is MIT writing me, a junior, not even a senior yet, and the first thing they mentioned was that we heard you were a participant in the SHARP program, and we know this is a great program.

So, that is another benefit of SHARP is the prestige because people have also like stopped me in my school or teachers would

ask me well, what did you do this summer, and I said I went to Goddard Spaceflight Center, and the bell seems to go off in their head like oh, Goddard Spaceflight Center, and we get into a discussion about what I did, and they just seem to pleased, and I am pleased because that means I am being recognized for being, I guess, good enough to be in the program.

The confidence came when I decided to apply to these selective schools because I figured after being in the program for the first two years, I said well, obviously these people must have some confidence in my abilities, and maybe it is time I started taking confidence in my abilities, and I applied to the colleges and at first I was kind of skeptical as to whether or not I would get in, but of the five colleges I applied to, I only got turned down by one, and all five of them were very selective schools. I will not name them, but I will just move on.

And the next thing which SHARP does is it teaches professionalism because as a junior or a sophomore usually you do not know anything about the professional job market. You might have had a job, maybe, at McDonald's or something like that, but here you are at Goddard Space Center working with scientists, very professional people who are also very busy, and you have to create such an impression on them that they have confidence in your abilities to perform whatever task they assign you.

And once you have been in the program one or let me say two or even like one year, you get that kind of professionalism because you know exactly the tasks that you have to do, and it is not like in school where a teacher tells you we are going to do such and such a lab and then lay it out for you and say here are the steps for the lab, and I want you to write such and such. You have no such directives. Your mentor most likely will tell you, I want such and such done, and maybe he might discuss with you the possible ways of doing it, but the ultimate decision is up to you as the SHARP participant to finish the job and do it in such a way that it works, depending upon exactly what your results you were hoping for are.

One of the major benefits of SHARP is the communications skills it teaches us because as SHARP students we have to relate first of all to our mentors directly. If you do not know how to talk to a mentor, or scientist, you are most likely not going to have a very good summer, or a very good internship, period.

Then next you have to learn how to communicate with your peers in the SHARP program and that is also a great benefit, having such peers who are like-minded as you and interested in science and mathematics related career fields.

Because sometimes in high school you look around you and it is kind of depressing, or when you look around in the media you hear all this news about teenagers are not doing anything. Teenagers are selling drugs. Teenagers are killing each other off.

Then you get in a program like SHARP and you realize that that is not true, and here you have a set of 25 students who are like-minded and who are looking towards the future, and communications skills come in handy, especially when you have to come in front of a Senate Committee and speak.

Senator GORE. You are doing great.

Mr. TAYLOR. Thank you very much—and you get kind of nervous, but in SHARP you learn how to communicate because once in a while you will be asked to get up in front of a group and present your project and if you are fortunate enough you will be asked to come in front of a Senate Committee or a committee of teachers and explain exactly what the SHARP program is and what it does. So that is the last thing I would like to say about SHARP.

Once again, let me close by saying my thoughts on the Space program after SHARP. After SHARP, I kind of realize that the space program is more than just flying the Shuttle, and let me reiterate that again because my mentor this year is Mr. Henry Sample and he works in the optics department and the satellite that they are working with, you might be familiar with.

It is the COBE satellite—cosmic background explorer—and I got sort of a great insight into how the satellite is constructed and exactly what the satellite is supposed to do. Now, before I never understood it. I would have heard COBE and said oh, that is just another satellite that is going to fly up there and they are going to deploy it and I would not understand the mechanics behind it, let me say.

But after SHARP I really have an understanding of what COBE is and exactly what it does. Just the same with the Hubble Space Telescope and the many different projects that NASA is considering at this moment.

Let me backtrack a little bit. I forgot to speak briefly about my projects for my three years in the program. My first year I worked with Mr. Lee Nierhoff and Mr. Nierhoff was building a data logger which was supposed to fly on the Spartan satellite. That was before the Challenger disaster, but after Challenger they had to scrap the Spartan satellite.

Anyway, what I did that summer was basically I learned how to program in Basic, a computer language, and I wrote a program which interfaced his data logger and the PC and the program was supposed to extract data from the data logger and convert it to engineering data which scientists and engineers can understand.

My second year I worked with Mr. Douglas Ross in the electrical engineering branch and I learned another computer language called FORTH, and it is spelled F-O-R-T-H and I basically learned how to program in FORTH and learned about operational stack—the operational stack, let me say—and different kinds of concepts, and I built a bread board with Mr. Ross and so I got a little bit of electrical engineering.

This final year, what I am working on is a program called AIMS 2RT system and what I am doing right now is, I am evaluating the AIMS for the optics branch, because AIMS is a fairly new system and it has some limitations which the optics branch does not know about yet. So my job this year is to research that and evaluate it and give a final report on it.

I thank you very much.

Senator GORE. Well, that was a great statement. Thank you. Our staff director and technical expert here leaned over to me, listening to these statements and said, "I am in trouble." He said, these kids are coming on so strong they are going to be able to do my job better than I do in a few years.

I do not think I have ever heard a more eloquent explanation of why it is important to establish expectations for students that are in line with their abilities.

If you expect achievement and excellence, you are going to get achievement and excellence. If you expect just failure, you are going to get failure, and to hear you talk about the thrill that you experienced when you realized that people had high expectations for you is really a very moving experience.

Our final witness on this panel is James Ruffin at the University of Maryland. Welcome.

STATEMENT OF JAMES RUFFIN, UNIVERSITY OF MARYLAND

Mr. RUFFIN. Before I start I would like to point out that I share Miss Duncan's hopes for a peaceful world and coexistence through our space exploration.

I had—I guess this is sort of a follow-up in that I was able to participate in the SHARP program back in the summers of 1982 and 1983, so that hopefully I will be able to show you where your money was spent.

As I said, I was in SHARP back in 1982 and 1983. I worked in the Laboratory for Atmospheric Sciences in the Oceans and Ice section with a geophysicist. With that I had an opportunity to gain hands-on experience with computers, to gain exposure into an every-day technical work environment and also to gain insight into the various career choices available in the technological field.

I will point out that while I was attending a math-science magnet high school—Baltimore Polytechnic Institute—I really did not have any idea as to what career choices there were out there beyond the traditional, I think I am going to be a scientist, I think I am going to be an engineer, I think I am going to be a doctor, and I praise this program in that it gave me an opportunity to explore the various occupations that are necessary to support space exploration and the uses of the technology that we gain through space exploration.

Also, when I graduated from the SHARP program and from high school I went to the University of Virginia where I took course work in English and scientific computing with the idea that I would go to law school, and I also had an opportunity to return to Goddard each of those three years and in the employment of a contractor, science applications research, doing the same kind of data analysis with a geophysicist.

During those summers we completed and published an Antarctic atlas, we produced numerous papers——

Senator GORE. What year was that, on the Antarctic atlas?

Mr. RUFFIN. That was back in the summer of 1986.

Senator GORE. Was it the polar region?

Mr. RUFFIN. Yes.

Senator GORE. That was the Antarctic. Let me just interject there that I think that is one of the finest publications—it was put out by the CIA, right?

Mr. RUFFIN. Yes.

Senator GORE. That is one of the finest publications of its kind I have ever seen. I have got two copies of it up in my office right

now and I have shared it with many people. I went to Antarctica in December and took that along with me and so I am proud to know you had a hand in creating that.

Mr. RUFFIN. As a matter of fact, during the summer that I was there my mentor was in Antarctica and my job was basically to communicate with him through the computer and to take the data that he was gathering down in Antarctica and process it to produce the kind of numbers and plots and pictures that were necessary and then to send that information back to him by computer so that he could use it, and there would be as little time lag in between his gathering the information and his being able to do something with it.

In choosing a career, I did not really want to go into the geophysics, even though I did find the work that I was doing challenging and quite interesting. I found that my interests lay in other areas and I was more fascinated by the computer aspect of the work that I was doing at the time.

In so doing I happened to be researching some of the various occupations available and came upon computer law, which is using law school and using the law to examine the various capabilities of computers and to integrate the knowledge and the technology that we are able to gain from space exploration into everyday life both for commercial uses, for medical uses and for defense uses.

In terms of my views on space, I believe that—I was fortunate enough to grow up in what I consider to be the space age, having been born at the end of 1965. As a matter of fact, I can remember little bits and pieces of that first walk and the subsequent space walks.

I did not exactly know the magnitude of what was going on, but just by all the TV breaks and the excitement that it gathered I knew that something big had gone on and having been able to grow up to see the technology gained from the space program used in such common uses as artificial limbs, microchips, communication—even things like the Dustbuster and freeze dried coffee—I am happy to see that.

I would like to point out that I believe that the space exploration is important in itself for commercial and defense uses as well as for environmental uses, but also because the technology that we gained, I think it forced the finding of technology in that we are able to take that technology and to make our lives here on earth better.

Therefore, in conclusion I would just like to say that I hope, and it is my sincere hope, that you through this Committee and through the government continue to put funding into programs such as the SHARP program that I was able to participate in, because I do believe that it gives students at an early age insight into the various opportunities available, as well as ideas of what they are capable of doing.

You are hearing some pretty impressive things from the members of my panel here, from students at a very young age and I think we can all agree that that money is being well spent when you hear them present their testimony.

I also believe that if we can venture—right now we are discussing the building of a permanent space station as well as venturing

on to Mars. I would like to give one citizen's vote for yes, for appropriation to do that, just because I believe that it is important for us both on an every-day basis and on a technological basis and on an environmental basis.

Thank you.

Senator GORE. I agree with you, and let me say that is another excellent statement. You were very young when that first moon landing took place. Was anybody else here born when that took place? On the panel, that is.

I was going back and I got from the staff some of the headlines of that day. "Neil Walks the Moon: A Great Moment of our Time"—that from the "Houston Post." The whole front page is completely devoted to stories about it.

Here is a column of analysis entitled, "Old Man Moon Not the Same." Here is the "Washington Post" from that day: "The Eagle Has Landed. Two Men Walk on the Moon." "One Small Step for a Man, a Giant Leap for Mankind." "Here is the Los Angeles Times": "Extra—Walk on Moon." Just such a dramatic time.

As I said in the statement opening this hearing today, it was a time when we were especially proud to be Americans, but just a thrill to be part of the human race, that we had reached that milestone, and a lot of young people who were in school at that time began to go into science as a result.

At least, the numbers of students going into science-related fields went way up throughout the Apollo years and then when we stopped the Apollo program and stopped going into space the numbers came back down again. I do not think that is a coincidence. I think there is a connection and I have never heard more eloquent statements of why we should have an American space program than the statements that were made here today.

I really appreciate all of you coming, and as one of you said—I think James Ruffin at the end—said you support the space station. I do, too. I think that it is an important link between our past achievements as represented by the Apollo program and the moon landing and our future role in space, which several of you pointed to as exciting and inspiring.

I agree with you that our destiny is to explore space. We are meant to go out and explore space, and when people talk about the cost, as they should, they should also talk about the benefits, not just in terms of the new inventions that come about because of our space program, but also in terms of young people being inspired; young people realizing that if humankind has great expectations for itself, then there is literally no limit to what each individual boy or girl, man or woman, can achieve.

So I thought one of the best ways to commemorate this important anniversary would be to hear some of the aspirations and statements from young people who are especially involved in thinking about and working in America's space program.

I hope that tomorrow, when President Bush makes the long-awaited statement which has been advertised as his statement on space policy, that he will address the youth of America and give you a challenge equal to the one which John F. Kennedy gave to my generation and I hope and expect that will take place tomorrow.

In any event, those of us who are strong supporters of the space program ought to take heart from the wonderful statements here that we have heard today and renew our dedicated efforts to ensure a future for America's role and leadership in space.

I am going to hold the record open for statements from my colleagues who are on the floor debating the State Department authorization bill, but before closing this hearing I would like to again express my gratitude to each of you—to the other witnesses who are here as well, but I would like to especially say one more time how impressed the Subcommittee is and how impressed I personally am with the statements you have made.

I really am moved by them and I congratulate you on the fine records that you are making and the outstanding work that you are doing. I fully expect that a few years from now some of you will be back here testifying about your achievements at another level of expertise and we will all be reading about some of you as you go forward and do great things in your lives, and we wish you the very best.

I also would like to indicate that the Subcommittee will insert in the Record for today's hearing, two statements from students that were not able to participate at today's session. These students are Laura Randall and Laurence Reszetar.

Thank you all for coming and this hearing stands adjourned.

[Whereupon, at 4:30 p.m. the hearing was adjourned.]

[The following information was subsequently received for the record:]

STATEMENT OF LAURA RANDALL

Good afternoon, Mr. Chairman and Subcommittee members. My name is Laura Randall. I would first like to thank you for the opportunity to share my experiences as a participant in the Summer High School Apprenticeship Research Program or SHARP and my views on the Space Program. I am a 20 year old student entering my fourth year studying Computer Science and Economics at the University of Maryland College Park. I am a third year intern with INROADS, a program that accepts talented minority youth and places us in business and industry to prepare us for corporate and community leadership. My current position is with IBM in Rockville, Maryland, where my responsibilities include assisting in the management of the Database for our Internal Revenue Services contract.

I participated in SHARP in the summers of 1985 and 1986, my junior and senior years of High School at Goddard Space Flight Center. My first project was in the Very Large Scale Integration Lab where communications data chips that trap information from satellites were designed on the Computer Aided Design system. My job was to construct a database that contained all inventory information about the lab equipment. Using bar codes and an optical reader, data was stored for easy access and availability. My second summer was more challenging. I was assigned a task that I later found out I was not expected to complete. I had to write a program that identified different temperature readings by voltage and that controlled instruments use in cooling down equipment in space.

At first, I was overwhelmed. But, in order to attack the problem constructively, I had to draw resources from within myself that I did not know I had. I researched at several libraries the terms that were unfamiliar; and most importantly, I learned that the only stupid question is the one I don't ask.

I can sincerely say that by being exposed to a real problem solving situation that forced me to learn how to ask questions and research that I am where I am academically today. I also built up a self confidence that I never had before. After participating in SHARP, I had experienced speaking before my peers, the scientific community and I received training to become a professional—something 95% of my classmates had not. As an alumna of SHARP, I have the unique opportunity to facilitate career workshops on topics such as communicating effectively, interviewing skills and how to get the most out of summer internships.

As an American, I believe that learning about the past helps us define our future. On July 20, 1969 the United States embarked upon a unique hallmark of success in space. The Space Program has continued to contribute to our learning since that day. The Hubble Space Telescope, when launched, for example, will aid the Unversity of Maryland Scientific Community as well as other scientists in determining the age of our universe by producing sharp, clear immages of 18 billion year old star clusters. The Space Program in the past has helped enhanced international relations with joint projects such as the International Ultraviolet Explorer with the Europeans.

The Space Program is essential to the growth of the United States as a Scientific Pioneer and as an avenue toward improved international relations. SHARP and programs like it are essential to the youth—our future leaders of America. The Federal Government has made inroads in educating its youth through the educational space programs and I hope it will continue with its mission.

Mr. Chairman, my objectives for the future generations of space explorations are that the curriculum in schools be enhanced and that more students, particularly minorities and women be exposed to the wounderful opportunities to learn. I understand that programs such as SHARP must be selective in their admissions but the other students must not be left out in the spread of knowledge. Having the proclivity to excel in the sciences is not enough. It is imperative that students be exposed to the tangible world in the scientific community in order that they may better define their career goals and get an early start in contributing to technology.

Lastly, it is my dream and sincere hope that the new horizons in space technology will bring about harmony and peace; and that peace may be achieved by uniting together for a common goal for the advancement of all mankind.

STATEMENT OF LAURENCE JOSEPH RESZETAR, CHARTER SATELLITE MEMBER OF THE YOUNG ASTRONAUTS

Mr. Chairman and distinguished members of the committee, it is an honor for me to appear before you today on the eve of the 20th anniversary of the blue-ribbon day when the United States dramatically made its mark in space by landing men on the moon.

I was not yet born. In fact, more than half of the humans now on earth were not yet born, and to all of us that event is mere history, although it is history filled with suspense and spine-tingling adventure.

You have asked for the young astronaut's views of the Nation's space program, how the space program influences our school work and what we think should be the goals and objectives of our Nation's space program.

My view of our space program began with the blast-off of Dr. Sally Ride on board STS 7, June 18, 1983. My mother was invited to watch this historic launch and she got permission to include my father and me. I was 7 years old. When I was told the significance of the flight, one of my first questions was "Why did it take 20 years for an American woman to become an astronaut?" And now I ask, why is it taking so long to take our next major step into space?

At the Kennedy Space Center, we had to arrive at the launch site before dawn. I can still feel the electricity in the air before the launch. The sounds of the swamp intermingled with the excitement of the guests. Birds and bugs were making the early morning noises they have made for centuries.

This was interrupted by the flash of the blast off, followed by a few seconds later by a termendous roar. The silence that followed that roar was incredible! Every living thing was quite. I was in awe.

I will always remember the feeling of that moment. I wish more people my age could have the same experience. Since than I have had a keen interest in space and astronomy.

At my request in 1986, when I was 10 years old, my parents sent me to space camp. I "became" an astronaut for a week. We ate the food astronaut's eat in space, we experienced the spacesuits, helmets, backpack life support units and the manned manuvering unit [MMU] which uses rockets to propel you through space.

We built and fired our own rockets, we experienced the zero gravity of space, we divided into crews to conduct a simulated mission, using NASA command control center equipment to checkout, countdown, launch, orbit and return to earth, using what we had learned during the week. We received space camp wings during the graduation ceremonies. It was an incredible week! It really "turned me on" to the space program.

Space is "our" future—my generation and those growing up behind me.

If we can get our young people interested at an early age, they, too, will become infected with the "space bug" and will be able to make contributions to our society which we can now only dream about. As a competitor in the international market place, now is the time for America to inspire our youth to the wonder of space and sow the seeds for a future generation of scientists and space explorers. The young astronauts council is an excellent vehicle for this but it needs more visibility and support in order to achieve more participation within the school systems.

It would seem that Congress could set an example for young Americans, and to the international community, as well by providing money so model programs could be started in schools and other educational institutions throughout the Nation, using local and State money to match the Federal money. Since we are promoting science and mathematics education, this would seem to fit the mandates of the Department of Education and the National Scienc Foundation. NASA could help, too, by providing space related information for all ages, since the educators and parents need to be informed in order to followup and keep up with their children. This would keep everybody motivated. Are there any joint projects between these agencies which could assist in the development of more active young astronaut chapters? If not, why not?

There is also an international component in young astronauts. Japan has also started a Young Astronaut program. A youth exchange program has begun so children of different lands can learn what other countries are doing in their space programs.

I have just learned about the new Challenger Learning Center in Greenbelt, MD, which is part of the Prince George's County public school system. It will provide a realistic working environment in which to teach students about space exploration and discovery. Its grand opening this week coincides with the national activities commemorating the 20th anniversary of man's first landing on the moon. Its principal feature will be the operation of a "mission site" that provides the equipment, materials and resources necessary to simulate the environment of a space station and mission control facility. About 30 students at a time will participate in a 1 to 2 hour simulation that presents tasks and problems involving critical thinking, computation and communications skills. This is a joint public/private sector effort with the State of Maryland, the County Government, the Board of Education, the Economic Development Corp., the Advisory Council for Business and Industry, IBM, COMSAT, the Gannett Foundation WTRK, the Driggs Corp., the Challenger Center for Space Education National Network and the Challenger Center for Space Science Education. This is a perfect example of what could be accomplished across the Nation if we had cooperative efforts between Federal agencies that could also invovled the private sector working with State and local governments.

I am now 12 years old. In September, I will be a 9th grade student at the Severna Park, MD, Senior High School. I have been fortunate to participate in gifted and talented programs through my public school and through the Center for the Advancement of Academically Talented Youth at Johns Hopkins University. I have studied oceanography, leadership skills and "our future: where are we going" at the Ann Arundel Community College; psychology an chemistry at Western Maryland College; oceanography and physics at the U.S. Naval Academy; writing skills I and European history at Johns Hopkins. I enjoy playing the piano, lacrosse, basketball, tennis and golf. I have also played soccer and baseball. I won first place in the Oak Hill elementary science fair in the 4th and 5th grades and second place in the Anne Arundel County science fair in the 4th grade. I have visited 33 states in the United States, one U.S. territory and 10 foreign countries.

In 1984, I received a national award from the White House Conference on Library and Information Services task force, "in recognition of his commitment and special support for the betterment of libraries and the improvement of library services." I am the youngest member of WHCLIST, which has members in every State and territory.

I am a charter satellite member of the Young Astronaut's and I assisted in founding a Young Astronaut's chapter at the Severna Park middle school in 1987. In 1 year, I singlehandedly raised $1,525.00 from local service organizations for our chapter which qualified it to become a "model" chapter.

I received the Young Astronaut council's certificate of special recognition in March, 1989, "in recognition of outstanding contribution to space exploration and space education." The seal on the certificate had been flown in space.

In many States, September 30 is "Young Astronaut's Day." In Maryland, we did not have this designation so, last year I wrote to Governor Schaefer and he issued a proclamation declaring September 30 "Young Astronaut's Day" in Maryland. As you can see, I am serious about space. Others would be, too, given the opportunity.

Young people my age will be part of the first real space-traveling generation. We'll design spacecraft for interplanetary exploration, occupy space stations and help solve scientific mysteries that have perplexed mankind for centuries. We will also be tomorrow's corporate leaders, doctors and educators. We will "use the technology of the space program for the benefit of all man kind," as Werner Von Braun envisoned when he dreamed of establishing a "space camp."

I have also been fortunate in that my parents have actively supported me in my space interests. I have had the opportunity to meet with Senator John Glenn in his office. We talked about his experiences in flying and space travel. I hope to follow in his footsteps, first as a Naval aviator, then as an astronaut, and, finally, as a public official.

Landing on the Moon was "one small step for a man and one giant leap for mankind." The space station would be the second small step toward another giant leap for mankind, in our quest to explore our planetary neighborhood.

I have read that now, 20 years later, astronaut Edwin "Buz" Aldrin, Jr., has said "the promise of Apollo was never fulfilled." I find it interesting that it took only 8 years to achieve President Kennedy's goal of landing a man on the moon and returning him to earth, but it has taken over 20 years of indecision to just get to the talking stages of the next step: getting the space station into production, even though the design and technology have been developed.

A permanent space station was originally envisioned to be included in the Apollo Program but was not accomplished because some people felt it was too expensive and would not make the money available to accomplish it. Look where we would be now, 20 years later, if our leaders had had the vision and the fortitude to find the money at that time. We could be here talking about building the second generation space station and making additional voyages beyond our solar system. Since 1984, when President Reagan endorsed building the space station in his state-of-the-union address, the space station's schedule has slipped three times because of budget cuts and technical reasons. Yet, historically, for every dollar the U.S. Government has spent on space projects, it has generated about $7 worth of economic activity. Over the 10-year life of developing the space station, which will be in use for 20–30 years, it is projected that work relating to the space station will create over 50,000 jobs in the United States private sector in more than a dozen States.

It appears that Dr. James C. Fletcher, former NASA Administrator, was correct when he said that "the Currents of history are rapidly taking us toward a decisive fork, an irreversible set of choices that will determine for our lifetimes the role and position to which the United States can aspire in carrying forward man's destiny beyond the frontiers of earth." In other words, will the United States be in the leadership role or will we become followers? Our Nation's destiny is at stake and we must not be afraid of this responsibility. It appears we can no longer take our leadership for granted in this international arena which is becoming more and more competitive. The future belongs to those who prepare for it.

In the programs currently being shown on television and written about in the papers about our space program, the cost of the space program is a major concern. The accomplishments of the past and the continuing promises of the future have been made at a low price for the values received. The Apollo Program was an investment of about 5 percent of the total Federal budget then. Today, NASA's budget is 1 percent of the total Federal budget. Imagine what could be done if there was a compromise and that could now be 2 percent. We are not a poor Nation. Every year American consumers spend about $14 billion on candy, chewing gum and video tapes. Can we not spend 35 cents out of every $100 that taxpayers pay to assure that the riches of outer space become part of our lives? Don't deny us this frontier. Young people everywhere share in this dream. The space station would blaze the trail and give us a permanent foothold in space. The space station is our gateway to freedom—freedom to live away from Earth, freedom to visit, to explore and to settle elsewhere in the solar system. The space station is worth doing right and that means a national commitment to providing the needed resources now. Investing now in the space program is really investing in our future. History does not note also-rans, so the United States must be the leader in the "second golden age in space" and not be the country which only periodically visits space, remaining virtually earth-bound. Let's show the world that the United States still has that "can do" spirit!

The products of space systems have become so much a part of our daily lives that they have become invisible and we take them for granted, such as the educational programs, office systems and computer games, which we enjoy on a daily basis, household products, the telecommunications, navigation and environmental monitoring which are done through the use of satellites we now have in orbit.

Pollution, dwindling resources, and over-population are but a few of the problems facing the world today. These are problems that may be solved in space—because we will be living in close quarters, recycling all resources, and having to clean the air. These problems can be solved faster if we make a whole-hearted commitment to the space program and then use space solutions on Earth. If we let these problems wait to be solved here on Earth, we can expect unacceptable delays which could very well result in wars or the destruction of our environment. In any case, we could be witnessing the consent of another dark age, 500 years of human regression and stagnation. If we survive at all.

One of my goals is to be the commanding officer of the international crew which makes the first manned space voyage to Mars. It is currently projected for the year 2010, when I will be 34 years old. I believe it is possible. I look forward to "stopping for the night" at the freedom space station as it orbits at about 250 miles above Earth, visiting with the crew of astronauts, watching the earthscape below with a sunset or sunrise occurring every 45 minutes, and then heading on for a fourteen month journey to Mars and the return to Earth, again stopping at the space station.

The space program has intangible benefits as well as tangible ones. It has allowed the children of my generation to learn a cosmology far different and far more accurate than we could learn even one generation ago. Space exploration has opened windows into the universe that will never close and has influenced the way math and science are taught in our schools.

The launching in April 1990, of the Hubble space telescope has the potential to dramatically change what we are now learning in school and how we learn it. It will be used by astronomers for decades to do research exploring our universe out almost to its edges and back almost to its origins. It will have many missions, and will expand man's vision in space because it will be located above our cloudy atmosphere and will give us a clearer picture of the galaxy.

We Young Astronauts, and others of my generation who do not even know about Young Astronauts, are closely watching the progress of Magellan, which is headed toward Venus. This has taken 17 years to achieve! We are looking forward to the launching of the Galileo probe to Jupiter in October, so we can take a closer look at our solar system's largest planet and its Moons.

You asked what Young Astronaut's think should be the goals and objectives of the Nation's space program. I am a bit concerned because I haven't learned of a precise set of long term goals or objectives that have been set in the same way that President Kennedy set them when he said we would accomplish a certain mission within a 10 year period. There continues to be waffling and attempts to cut funding for our space programs even though President Reagan in 1984 backed building the space station, and the National Commission on Space, a commission the U.S. Congress created in 1985 to define long-range goals, recommended the space station, a lunar base and manned trips to Mars. A presidential directive on national space policy was signed by the President in 1987 that stated that space leadership was a fundamental objective, endorsed the space station and set long range goals "to expand human presence and activity beyond Earth's orbit into the solar system." The national space council, headed by the Vice President, supports the space station. President Bush supports the space station. He has requested $2.05 billion in the fiscal year 1990 budget to continue work on the station. Congress is reportedly going to cut that in half. I find this confusing because a poll taken in 1988 showed that two-thirds of the American voters said the space program should be expanded. Americans put space high on their list of national priorities because they understand that space exploration is important to the Nation's economic, social and political well-being, both now and in the future.

It might help children and young adults my age to live with certain circumstances if we knew we were all working toward national goals, objectives, and target dates that had been set by the President and Congress, accurately reflecting their constituents wishes. These national goals, objectives and target dates would not constantly be revised or at risk of elimination, with specific results expected by a certain year, even though the President and Congress might be retired by the time the results were known. I feel we can't keep changing the plans and dates for space programs because we do not have long range goals determined and target dates firmly in place. In short, I think we need a clear strategy, with long term goals defined and developed to cover a 20 year period. Please put the machinery in motion to give my generation, and those growing up behind me, a permanent foothold in the future. For instance, the technology is now in place to develop the space station. Let's do it now.

Other countries, including the Soviet Union, understand the value of space systems—the profit, productivity, prestige and national strength which are byproducts

of a space program. By the time our space station is launched, the Soviets will have been living and working in space for over 20 years on a space station. Japan, the European Space Agency, and Canada will continue on with or without us, as they have made major commitments of their resources for what are now joint efforts, with the United States currently in the leadership role. Are we to be embarrassed as a Nation again when we are forced to go back on our word, as happened with the Giotto mission to Halley's Comet and the solar polar spacecraft, when we promised Europe our cooperation and then did not honor our promise?

Could we have a goal that by October 4, 1997, the 40th anniversary of the Russian's giving birth to the space age by launching Sputnik I, that the United States will have successfully in orbit about 250 miles above Earth, a permanently manned space station, with planning well underway for an international cooperative manned voyage to Mars by 2007, the 50th anniversary of the space age? May we include the goal that we be able to safely travel and maybe live far beyond the confines of Earth's gravity by the 60th anniversary of the space age? We must remain aware of mankind's needs and wants to explore, discover, understand and apply what we have learned for the betterment of life on Earth and in space. The possibilities are as exciting and limitless as the horizon of our vision. Many of man's long held dreams will become realities as we earthlings explore our planetary neighborhoods. As we approach the 500th anniversary of Columbus's historic voyage, we need more Queen Isabellas to support the journeys of future Columbuses. We need a firm commitment when it comes to this last frontier—space.

I think I speak for my generation when I say that we will fulfill the goals, if you will give us the chance to do so. Thank you.

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